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MINISTRY OF AVIATION

AEROPLANE AND ARMAMENT EXPERIMENTAL ESTABLISHMENT

BOSCOMBE DOWN

1st Part of Report No. AAEE/866/5

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SHACKLETON MK. 2 PHASE 3

NAVIGATION AND RADIO C.A. RELEASE TRIALS

PRESENTED BY

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AEROPLANE AND ARMAMENT EXPERIMENTAL ESTABLISHMENT
BOSCOMBE DOWN

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~~Navigation and Radio C.A. Release Trials~~ [S]. (8)

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Summary

C.A. release trials were carried out in Shackleton Mk. 2 Phase 3 WG 556. Trials flying totalled 32 hours 55 minutes in 12 sorties.

Temperate release is recommended for the use of the navigation and radio equipment subject to the reservations contained in this report. Installations remaining unchanged from the Phase 2 Mk. 2 Shackleton are cleared by analogy to that aircraft.

This report is issued with the authority of

f. Commandant A. & A.E.E.

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/1. Introduction ...

1. Introduction

Trials of the navigation and radio fit of the Mark 2 Phase 3 Shackleton were conducted at A. & A.E.E. in the period from 14th September 1965 to 26th November 1965 under the authority of M.O.A.(H.Q.)D/R.A.F.(C). These trials were undertaken in accordance with Navigation and Radio Test Instruction NR 15/65 dated 9th April 1965 and were carried out on Shackleton WG 556. Investigations were conducted into the behaviour of the following equipment:

1.1 Communication

H.F. STR 18 B2 (ARI 5874)
Intercomm (ARI 18089)
M.F./H.F. Receiver AD 118 (ARI 23126)
U.H.F. ARC 52 (ARI 18124)
V.H.F. AD 160 (ARI 23117/2)

1.2 Navigation

Radio Compass AD 712 (ARI 23084)
Gee Mk. 3 (ARI 5816)
I.L.S. (ARI 18011)
Tacan (ARI 18107)
Radio Altimeter Mk. 5A (ARI 18215)
Blue Silk (ARI 5885)

1.3 Tactical

ASV Mk. 21 (ARI 5878)
I.F.F. Mk. 10 (S.I.F.) (ARI 5848)
Orange Harvest (ARI 18144)
Sarah (ARI 5876)
Twin Sonobuoy Mk. 1C and Homer (ARIs 18209,18101,18157)
U.H.F. Homer, Violet Picture (ARI 18120)
Tactical Position Indicator
Autolycus Mk. 3A

1.4 Heading Reference System

G.M. 7 Gyro Magnetic Compass
P.12 Standby Compass

2. Previous Trials and Reports

2.1 The navigation and radio assessments of the earlier versions of the Shackleton Mk. 2 were reported in the 8th, 32nd and 33rd Parts of AAEE/866/1. The Phase 3 modernisation of the Mark 3, which is essentially the same as that for the Mark 2 was reported in 1st Part of AAEE/866/4.

2.2 An interim letter report on the present trials was issued under reference ANR 2J/05 dated 6th December 1965.

2.3 A further report recommending the tropical release limitations will be issued later.

/3. ...

3. Trials Experience and Results

3.1 Trials Effort

Shackleton Mk. 2 WG 556 was allocated to A. & A.E.E. for navigation and radio temperate C.A. release trials during the period from 14th September 1965 to 3rd December 1965. During this time both air and ground investigations of the behaviour of the equipment listed in para. 1 were carried out. The total flying effort for the trial was 12 sorties consisting of 32 hours and 55 minutes flying time. The final sortie was flown on the 26th of November 1965.

4. Communication Equipments

4.1 H.F. STR 18 B2

The installation is unchanged from the Phase 2 fit and release is recommended by analogy. The equipment was used frequently and successfully throughout the period of the trials.

4.2 Intercomm

The intercommunication equipment is the same as in the Mark 3 Phase 3 aircraft and release is recommended by analogy to the latter. Some breakthrough is experienced from various radio channels and from electrical sources (see Appendix II) but none of this is serious. Noise levels on WG 556 were, in fact, less than those experienced on the Mark 3 trials aircraft.

4.3 M.F./H.F. Receiver AD 118

4.3.1 This installation is the same as in the Mark 3 Phase 3 aircraft and the one small criticism concerning lack of internal illumination of the frequency range changer still applies. Otherwise the installation is adequate. The receiver can be connected to either the trailing aerial or one of the fixed aerials (see Appendix I concerning criticism of the trailing aerial).

4.3.2 M.F. performance was continuously tested during the flight trials. Numerous frequencies were tried and ranges of 2 to 3 times the rated range of various ground beacons were achieved. H.F. performance was similarly tested. Loud and clear signals were received at ranges up to 900 n.m. Occasionally identifiable signals were picked up at ranges of 1,800 nautical miles (e.g. Nicosia from Northern Ireland). The interference from Blue Silk referred to in Appendix II badly affected reception of weak signals.

4.3.3 C.A. release is recommended for the M.F./H.F. receiver.

4.4 U.H.F. ARC 52 and U.H.F. Homer, Violet Picture

These equipments are unchanged from the Phase 2 fit and release is recommended by analogy. The ARC 52 was in continuous use throughout the trial and no abnormalities were observed.

/4.5 ...

4.5 V.H.F. AD 160

The installation is physically adequate but the aerial radiation patterns (see Figures 2 - 6) are outside the specification, RAE/XRSP 3247, in that there is an 11 dB drop in signal strength over 10 degree sectors at 150 degrees and 170 degrees relative. However range checks in this area of doubt were carried out and near maximum possible line of sight ranges were achieved. The EAM 35 amplifier in the M22 interconnecting box was adjusted so that its output power was 200 mW. This proved to be a satisfactory level as in the Mark 3 Phase 3 trials. (See 1st Part of Report AAEE/866/4 Appendix IV). C.A. release is recommended for the V.H.F. AD 160.

5. Navigation Equipments

5.1 Radio Compass AD 712

5.1.1 The installation is the same as in the Mark 3 and the same reservations are made about it. Firstly the restriction of air space around the receiver M2 is suspected of being a contributory cause of overheating. Secondly the navigator's control unit is poorly positioned (see para. 9.5).

5.1.2 Ground swings of the radio compass were carried out against the Droitwich (200 Kc/s.) and Brookmans Park (908 Kc/s.) beacons. The quadrantal error correction was found to be -2 degrees as in the Mark 3 trials. The results are shown in Figures 13 and 14, the Q.E.C. was set in.

5.1.3 C.A. release is recommended for the radio compass.

5.2 Gee Mk. 3

Gee 3 was used on all sorties during the trial. No difficulties were experienced in receiving usable signals in the area of coverage and no excessive interference was encountered. C.A. release is recommended.

5.3 I.L.S.

The I.L.S. installation is unchanged from the Phase 2 aircraft and C.A. release is recommended by analogy.

5.4 Loran (APN 9)

Checks were carried out on channels IL0, IL1, and IL6 in the area north of Ireland. Usable signals were received on all three channels. Some interference arose from the STR 18 and the A.S.V.21 but fixing accuracy was not degraded. C.A. release is recommended.

5.5 Tacan

The Tacan installation is basically unchanged from the Phase 2 fit. It was used frequently during the trials period. Range and overhead performance checks were carried out against a number of beacons. The range checks showed that near maximum line of sight ranges were possible, e.g. loss of lock on Boscombe Down beacon at 10,000 feet at 118 nautical miles. Overhead performance checks against Sennen and Boscombe Down beacons showed a circle of uncertainty of 3 miles at 10,000 feet. C.A. release is recommended.

/5.6 ...

5.6 Radio Altimeter Mk. 5A

The installation of the transmitter/receiver and power unit is adequate. The aerials are in the same position relative to the fuselage as in the Mark 3 aircraft (see Figure 1) but the tail down attitude of the Mark 2 introduces unsatisfactory features. This might be expected in view of the recommendation in Radio Installation Memorandum 115 that the aerials should be placed as high as possible on the aircraft. Spurious readings occur on the instrument whilst on the ground and for the first few feet after take-off. Therefore it is recommended that the radio altimeter readings are not used below 50 feet and that the zero control on the indicator be set to 7 feet regardless of the readings observed on the ground whilst the equipment is switched on.

5.6.1 Calibration

The accuracy of the equipment was ascertained by calibration runs against the kinetheodolites at R.A.E. Aberporth and by sea-to-land runs near Burnham-on-Sea. The results of the Aberporth trials in the height bracket 100-5,000 feet are shown in Figure 11 and the sea-to-land results are in Figure 12. From the results the overall accuracy over land and sea is within the limits ± 3% of height ± 5 feet.

5.6.2 Aerial Leakage

The aerial cross-coupling attenuation was measured by simulating a leakage signal from the transmit aerial through a piston attenuator to the receive aerial. The attenuation was found to be 70.7 dB which is satisfactory. The altimeter indication held off at 5,000 ft. plus at altitudes above 10,000 ft.; also after being switched off and on again the altimeter re-locked at over 7,000 feet. Both these results indicate a low leakage level.

5.6.3 Release

C.A. release is recommended for the Mk. 5A radio altimeter within the accuracy limitations of ± 3% of height ± 5 feet and on the condition that reliance is not placed on the equipment readings below 50 feet.

5.7 Blue Silk

The Blue Silk functioned normally throughout the trials. Some unserviceabilities occurred but no problems were encountered in obtaining useful doppler information after routine servicing. C.A. release is recommended by analogy to the Phase 2 installation.

6. Tactical Equipments

6.1 ASV 21

This equipment is unaltered by the Phase 3 modernisation so release is recommended by analogy to the Phase 2 aircraft. The ASV 21 was used frequently and behaved normally.

6.2 I.F.F. Mk. 10 (S.I.F.)

The I.F.F. installation is essentially the same as in the Phase 2 fit. The aerial cable lengths are greater than the preferred 30 ft. but the equipment worked normally. Release is recommended by analogy.

/6.3 ...

6.3 Orange Harvest

The installation of the Orange Harvest is physically similar to that on the Phase 2 aircraft and is adequate. Performance is unsatisfactory because its operational efficiency is impaired by the equipment's incompatibility with other radio equipments on the aircraft (see Appendix II). C.A. release can only be recommended on the understanding that Orange Harvest will only perform at its best under conditions of radio silence.

6.4 Sarah

C.A. release is recommended by analogy to the Phase 2 fit. It is noted that this obsolescent equipment is now to be removed.

6.5 Twin Sonobuoy Mk. 1C with Homer

6.5.1 Installations

The installation of the Twin Sonobuoy 1C system is adequate including the new forward aerial. The radiation patterns of this aerial (Figures 7 - 10) indicate that its performance matches that of the existing aerial. It does not conform to Specification RAE/XRSP 3381 in that there are excursions in the pattern greater than 2 dB from the head on aspect, but acceptance of this is recommended in view of the practical results obtained. The Sonobuoy Homer and Homer/Violet Picture Switching Installations are analogous to the Phase 2 fit; the aerial installations continue to be unsatisfactory as exemplified by the failure of both aerials under moderate icing conditions in flight.

6.5.2 Performance

Flight trials were carried out against the Stage II trainer at R.A.F. Ballykelly with the assistance of the Air Sea Warfare Development Unit. Runs were made against patterns of active and passive buoys as shown in the table below. Equally good signals on both equipments were received at ranges over 20 nautical miles at an altitude of 1,000 feet. There was no loss of information attributable to the airborne installation except for a routine fault in the Doppler unit of the Master Indicator.

Run	Channel	Monitor	Channel	Monitor	Channel	Monitor
1	2 Active	Master or Second	11 Passive	By both when active buoys out of range	16 Active	Second or Master
2	14 Active	Master	11 Passive		16 Active	Second
3	14 Active	Second	11 Passive		16 Active	Master
4	6 Passive	Master 'A' and Second 'A'	7 Passive	Second 'B'	9 Passive	Master 'B'

/6.5.3 ....

6.5.3 Release

C.A. release is recommended for the sonics system except for the homer aerials, but it is recommended that further investigations be made into the susceptibility of the sonics receivers to H.F. harmonic interference (see Appendix II). The homer aerial fault is well known and must be rectified without delay.

6.6 Tactical Position Indicator

6.6.1 Some difficulty was experienced with both the installation and operation of this equipment. The installation problems are listed in Appendix III and are primarily due to either insufficient or inconsistent information in the various wiring diagrams. These difficulties were overcome by A. & A.E.E. after consultations with representatives of Bell Punch Ltd. and Hawker Siddeley Aviation Ltd. As a result of these consultations, amended drawings are being prepared and the problems should not recur with later production aircraft.

6.6.2 Two problems with the system's operation were encountered during C.A. release trials at Boscombe Down and a third problem was reported by A.S.W.D.U. personnel during a visit to R.A.F. Ballykelly. The difficulty encountered by A.S.W.D.U. occurs after turns or manoeuvres when the operation of the unstore motors causes a noticeable position shift in the G.P.I. Mk. 1C. This difficulty is the subject of a separate report being prepared by A.S.W.D.U. and is inherent in the present design of the T.P.I. system. Its effect on tactical operations can be minimised by operation of the system in the air data plus remembered wind mode and its occurrence does not affect C.A. release recommendations for the Shackleton Mk. 2 Phase 3. Operational experience may however, indicate that some later modification of the system is required.

6.6.3 Of the two operating faults encountered at Boscombe Down, the first is a purely mechanical fitting problem and should be easily rectified. It consists of intermittent loss of heading drive to the G.P.I. Mk. 4C especially during turns and manoeuvres. This is caused by poor connections between the G.P.I. Mk. 4C and the plug and jacking plate, and is a result of the method employed to secure the G.P.I. Mk. 4C in its mount. This consists of a locking device which holds the bottom of the G.P.I. Mk. 4C firmly against the bottom of the plug and jacking plate. The electrical connections between the two are, however, situated at the top of the plug and jacking plate and, during occasions of aerodynamic stress on the aircraft, sufficient separation to cause loss of contact occurs. The simplest solution to the problem is to provide some form of auxiliary 'C' type clamp which would lock the top of the G.P.I. Mk. 4C to the top of the plug and jacking plate although any device which ensured continuous and positive contact would be acceptable. This problem was also encountered with the Mk. 3 Phase 3 aircraft, but since the plug and jacking plate installed in the T.I. aircraft (WR 974) for that trial was of pre-production standard, the installation was recommended for clearance with the understanding that the fault would not be repeated on production items. It is recommended that, as an interim measure, the equipment should be released for use but that the operators should be warned of the possibility of heading loss in turns. For a final release of this equipment it is considered essential that design changes to allow more positive locking of the G.P.I. Mk. 4C to its plug and jacking plate be introduced.

/6.6.4 ...

6.6.4 The second problem encountered at Boscombe Down during the C.A. release trials of this equipment is the tendency of the wind unit indicator needles to run off to full scale deflection when "fast needle" is selected. This tendency was dependent on the quality of the Blue Silk inputs, being most pronounced during periods of weak and noisy doppler responses. Some "trade-off" between rapid response of the needle and stability of reading is no doubt essential in the design of the damping circuits for this unit, but since the operational role of the aircraft involves almost continuous flight over open water where doppler responses are notoriously weak and noisy, a slower response, more consistent with the quality of doppler inputs likely to be encountered, would be an operational advantage. No difficulty was encountered in the "slow needle" position and C.A. release recommendation for the Shackleton Mk. 2 Phase 3 is not affected by the difficulties encountered in the "fast needle" position. Some adjustment of the damping circuits may, however, be required to meet the needs of operational users of the equipment.

6.6.5 Tactical evaluation of the T.P.I. did not form part of the C.A. release trials of Shackleton WG 556, but some indication of the accuracy to be expected during en-route navigation was obtained by the amount of re-setting required to update the position computed by the G.P.I. Mk. 4C. This averaged between 3 and 4 miles an hour during some 15 hours flown with the T.P.I. fitted.

6.7 Autolycus Mk. 3A

Autolycus traces were obtained during the airborne compass swings. No difficulties were experienced in setting up the equipment and strong signals were observed downwind of built up areas.

7. Heading Reference System

7.1 Experience with the Shackleton Mk. 3 Phase 3 indicated a number of anomalies in the twin G.M.7 compass installation and, as a result, an extensive check of the installation in Shackleton Mk. 2 Phase 3 WG 556 was carried out during the C.A. release trials. This investigation revealed that the problems encountered with the Mk. 3 - divergence between the two systems in the air, magnetically unclean wing structures, galley interference and minor instability in the coefficients measured during compass swings - were also present in the Mk. 2 installation.

7.2 Divergence between the two compass systems in the air on WG 556 amounted to 1.36° ± 0.05°. This value is very close to that found on Shackleton Mk. 3 Phase 3 WR 974 (1.4°) and suggests that the behaviour of the system in the Mk. 2 is very similar to that in the Mk. 3. If further investigation reveals that a similar divergence is common to all Shackleton aircraft the problem can be alleviated by either offsetting the A coefficients by 0.7° during compass swings, or by setting a false value of variation in the air. Either action will ensure that the compasses read correctly in the air, but because offsetting the A coefficients has only to be done during ground compass swings and requires no adjustments in the air, it is less subject to operator error and is, therefore, to be preferred.

/7.3 ...

7.3 The second problem, that of magnetically unclean wing structures can only finally be resolved by providing sufficient separation between the detector unit positions and portions of the wing structure made from ferrous materials to yield detector positions that will remain within Av. P. 970 limits regardless of inadvertent magnetisation of wing components. It is recognised, however, that such a solution might be impracticable for structural reasons and that the more temporary expedient of degaussing the wing structure in the vicinity of the detector units may have to be adopted. It should be emphasised, however, that if the temporary solution of degaussing is accepted, the compass swinging intervals specified in D.C.I. S89/65 and D.C.I S32/65 should be adhered to closely and special care should be taken in checking the system after flying through conditions of high electrical activity. If these precautions are taken, no excessive operational problems are likely to arise from this source.

7.4 Galley interference problems in Shackleton Mk. 2 WG 556 did not appear to be quite as severe as those found in Shackleton Mk. 3 WR 974. The amount of interference experienced with all galley services on and the rapid boiling urn in operation did, however, amount to 0.3° (Appendix IV) a value which is slightly outside the limits specified in Av. P. 970. If double pole wiring such as that installed in WR 974 during the post Phase 3 electromagnetic studies reported by H.S.A. in their technical memo ARD/R/696/0101 is provided for Mk. 2 aircraft, the galley effect on the G.M. 7 should be reduced to an insignificant amount.

7.5 The fourth problem - that of unstable magnetic coefficients was the subject of an extensive investigation. This consisted of two detector position surveys carried out by Admiralty Compass Observatory (A.C.O.), eight ground compass swings and two airborne compass swings. On the first of the detector position surveys (Appendix V), a number of ferrous nuts and bolts were found in the vicinity of the detector position. Because these caused the positions to be well outside the limits specified by Av. P. 970, they were replaced by items of a non-ferrous nature before the second detector position survey. In this survey, (Appendix VI), the positions were still marginally outside Av. P. 970 limits but since no specific source of the difficulty could be traced, it was decided to proceed with the system investigation and to leave further position survey work until a more thorough investigation of Shackleton wing structures could be carried out by A.C.O. After the second detector position survey, the detector units were replaced and a normal ground compass swing carried out. An airborne compass swing and other trials work were then carried out with no alteration being made to the remote corrector voltage settings. One month later, after the completion of the remainder of the trials work, a series of six ground compass swings under various conditions and a second airborne compass swing were carried out, again with no alterations being made to the remote corrector voltages.

7.6 The results of all magnetic compass swings on Shackleton Mk. 2 Phase 3 WG 556 are summarised in Appendix VII. These show, for the seven ground swings which were carried out with no alterations to the remote corrector unit voltages, a 1σ variation of 0.16° in the B and C coefficients and a 1σ variation of 0.09° in the D and E coefficients. The statistical difference between these values amounts to $\sqrt{0.16^2 - 0.09^2} = 0.13°$ (1σ) and indicates that a cyclic error of this quantity affects the measurement of compass deviation in the Shackleton G.M. 7 installation. There are two likely sources of a one cycle error in the

/G.M. 7 ...

G.M. 7 system - variations in remote corrector unit voltage and transmission system errors. Regular measurements of detector unit voltages (Appendix VIII) were made throughout the swings and although these showed some slight fluctuation, their amplitude was so small as to be the possible result of parallax in reading the voltmeter and in any event was far too small to account for the variations in coefficients encountered. It therefore appears most probable that most, if not all, of the variation in coefficients can be accounted for by a one cycle transmission system error. Since the transmission system of the G.M. 7 includes synchro components rated (1σ) at 0.11° this result is quite compatible with the maximum accuracy that can be expected from the system and should cause no misgivings when encountered. The effect of this variation plus normal reading errors is to produce a probable error of 0.17° in any individual compass reading, a value that is considerably smaller than the likely error in the charted values of magnetic variation and which, as a result, will have an insignificant effect in the overall navigation system error.

The investigation also revealed that tapping the detector unit during a swing will decrease the probable errors calculated during a Fourier reduction of the heading data. However, tapping will not affect the closeness of the coefficients determined on a particular swing to the mean of those found on a series of swings and is therefore not recommended.

7.7 As a result of the trials work described above C.A. release of the G.M. 7 compass installation in the Shackleton Mk. 2 Phase 3 is recommended subject to user units being made aware that:-

(a) A discrepancy of about +0.7° in the number one system and -0.7° in the number two system occurs between the A coefficients found during ground compass swings and those that will be encountered in the air.

(b) Until modification of the aircraft's electrical system to provide double pole wiring to the galley is accomplished, deviations of about 0.3° may occur during operation of the rapid boiling urn.

(c) Aircraft magnetic coefficients outside Av. P. 970 limits are possible because of ferrous materials in the wing structure. For this reason, the compass swinging intervals specified in D.C.I. S89/65 and D.C.I. S32/65 should be adhered to closely.

(d) Coefficients measured during compass swings can show a 1σ variation of about 0.13°. This is mainly the result of transmission system errors and is quite normal.

7.8 P.12 Standby Compass

A magnetic survey and interference check was carried out on WG 556 at Langar prior to its delivery to A. & A.E.E. (Appendix IV). This showed that the P.12 compass position was within Av. P. 970 limits, but that changes of deviation outside these limits occurred when large electrical loads were imposed on the aircraft system. This is similar to the situation that existed with WR 974 the Mk. 3 T.I. aircraft prior to the re-wiring reported in H.S.A. technical memo ARD/R/696/0101. Because this re-wiring reduced the deviation changes on WR 974 to acceptable values, re-wiring of WG 556 and subsequent Mk. 2 aircraft to the standard of WR 974 is recommended.

/8. ...

8. Inter-equipment Compatibility

8.1 There are a number of incompatibilities between equipments. Those found on the ground trials are summarised in Figure 15. Those remaining during the airborne compatibility tests are detailed in Appendix II. The ASV 21, Blue Silk, Radio Altimeter 5, STR 18B and I.F.F. 10 were free of interference. The Gee 3, I.L.S., Loran, Radio Compass and Tacan were only subjected to slight interference from other equipments.

8.2 Heavy interference is caused by Blue Silk in the M.F./H.F. receiver AD 118. The sonics receivers are particularly susceptible to H.F. interference and the Orange Harvest is highly prone to interference from Blue Silk, V.H.F. AD 160, Tacan and ASV 21. Investigation is recommended into the interfering properties of Blue Silk and into the susceptibility of Orange Harvest and the Sonics system to interference. The latter is particularly important in view of the future use of the Sonobuoy Mk. 1C systems in the HS 801 containing a high power H.F. transmitter.

8.3 Considerable but predictable interference was observed under certain conditions on Sarah, U.H.F. and V.H.F.

9. Arrangement of Positions and Equipment

9.1 Radar Operator

The radar operator's position is adequate.

9.2 Sonics

The sonics operator's positions are adequate.

9.3 Radio Operator

A bonded cover is required for the exposed portion of the trailing aerial (see Appendix I). The remainder of the position is very cramped but adequate for the purpose.

9.4 Routine/Attack Navigator

Because there is considerable difficulty in reaching the compasses, Tacan and Blue Silk equipments from the Routine/Attack navigator position, routine navigation is only just possible from this position. Some of the switches on the Armament Selection Panel are beyond the reach of anyone strapped to the seat and can be comfortably reached only from a semi-standing position.

9.5 Tactical Navigator

No indication is provided to warn the operator when the compasses are operating in the D.G. mode. Since, in the event of a D.C. power failure, this can occur regardless of the position of the controls some such indication is required. In addition the frequency selector dial of the radio compass can only be read from a semi-standing crouched position. Apart from these difficulties the position is adequate.

/9.6 ...

9.6 Optical Plotting Table

This installation is identical to that in the Mk. 3 Phase 3 aircraft. Apart from a functional check out by A.S.W.D.U. personnel, no further evaluation work was carried out during the Mk. 2 Phase 3 trial. During the sonics evaluation at Ballykelly it was found that the Master/Second projector switch was easily knocked over; it is recommended that a guard is placed to the right of the switch to prevent this.

9.7 Pilot's Compass Mode Indication

No indication is given on the pilot's compass repeaters that the compasses are function in D.G. mode.

9.8 Main Equipment Shelf

The radio equipment layout in this shelf is included in Appendix I. The positions of the G.M. 7 amplifier and P.S.U. racks are such that the components in the front rack control the master indicator at the rear and vice-versa. Unless these positions are clearly labelled with the numbers of the systems to which they refer, this arrangement can lead to considerable confusion during compass swings.

10. Temperature Limitations

Limited temperature measurement work was carried out on WG 556. Full trials are being carried out on WL 737 at Hawker Siddeley Aviation. Until these results are available a recommendation for an upper temperature limitation cannot be made. The indications are that the aircraft environment is very similar to the Mark 3 Phase 3 which was recommended for release up to 42°C Outside Air Temperature. Therefore the releases referred to in this report are for temperate conditions only.

11. Conclusions and Recommendations

11.1 Temperate C.A. release is recommended for all the equipments listed in paragraph 1, subject to the criticisms and limitations contained in paragraphs 5.6 Radio Altimeter Mk. 5A; 6.3 Orange Harvest; 6.5 Twin Sonics System; 6.6 Tactical Position Indicator; 7. G.M. 7 Compass and 8.2 Incompatibilities.

11.2 The following recommendations should be implemented in the interest of efficiency and safety.

(a) The exposed part of the trailing aerial in the radio operator's position should be covered (para. 9.3 and Appendix I). - **Essential**

(b) Indications should be provided to show when compasses are in D.G. mode (para. 9.4 and 9.7). - **Essential**

/(c) ...

(c) Mk. 2 Shackleton aircraft should be re-wired to the standard outlined in H.S.A. Technical Memo ARD/R/696/0101 (para. 7.8)
- Essential

(d) Accessibility of Armament Selection Switches should be improved (para. 9.4). - Highly Desirable

(e) The visibility of the frequency selector dial on the AD 712 Controller between the navigation stations should be improved (para. 9.5). - Desirable

(f) The Master/Second projector switch should be guarded (para. 9.6). - Desirable

11.3 Investigations into the following are recommended:

(a) The susceptibility of Sonobuoy Mk. 1C receivers to H.F. interference (para. 6.5.3 and 8.2).

(b) The susceptibility of Orange Harvest to interference.

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Appendix I

Radio Installations

1. Figure 1 shows the layout of the aerials of the Phase 3 aircraft. The layout of equipment in the main crew compartment is virtually identical to the Mark 3 Phase 3 aircraft and photographs of the crew positions can be seen in the 1st Part of Report No. AAEE/866/4.

2. The positions of the main units of the radio equipments are as follows:

Nose Equipment Crate

ARC 52 Transmitter/Receiver TR 5
Tacan Transmitter/Receiver RT 220C/ARN 21.
Tacan Coupling Unit T 9546
Violet Picture AF Unit T 9635
Violet Picture RF Unit T 11037

Signallers Station

M.F./H.F. Receiver AD 118

Navigators' Stations

Intercomm Amplifiers
Radio Compass AD 712 Receiver M2
Loran Receiver/Indicator R 65/APN 9
Gee 3 Indicator T 26

Master Sonics Station

Indicating Unit CRT T 13232
Sarah TR 8088

Secondary Sonics Station

Indicating Unit CRT T 13232
I.F.F. 10 TR 4585
Orange Harvest Indicator CRT T 16613

Radar Station

I.F.F. 10 (S.I.F.) Coder 6466
A.S.V.21 Indicator CRT 4623

Main Equipment Shelf (reading from former B to former 15)

I.L.S. Glidepath R1965
I.L.S. Localiser R1964
V.H.F. Transmitter 6400
V.H.F. Receiver 6401
Gee 3. Waveform Generator T72
Gee 3 Receiver R.3673
I.L.S. Voltage Regulator T.60
STR 18. Power and Radio Unit 4192
STR 18. Voltage Regulator

/STR 18 ...

Main Equipment Shelf (reading from former B to former 15) (Contd.)

STR 18. Transmitter Unit 4188
STR 18. Control Unit 4243
STR 18. Aerial Tuning Unit 7180
Sonobuoy Power Unit. 13378
Sonobuoy Power Unit. 13378
Sonobuoy Receiver 'A' 13031
Sonobuoy Receiver 'B' 13031
Sonobuoy Amplifier 11144
Sonobuoy Filter Unit 13402
Sonobuoy Homer Comparator 7968
Sonobuoy Filter Unit. 13402
Sonobuoy Receiver 'A'. 13031
Sonobuoy Amplifier 11144
Sonobuoy Filter Unit 13402
Sonobuoy Receiver 'B' 13031
Orange Harvest Mixer Unit 9098/9
Orange Harvest Oscillator 9100/1/2
Orange Harvest Amplifier 13049
Orange Harvest Amplifier 7450

Under Rest Bunk

Orange Harvest Receiver R9982
Orange Harvest Power Unit T9986
Orange Harvest Power Unit T7495
Orange Harvest Power Unit T7824
Orange Harvest Power Unit T7496

Rear Compartment

ASV 21 Waveform Generator 4621
ASV 21 Power Unit 4624

Scanner Well.

ASV 21 Transmitter/Receiver 4626
ASV 21 Scanner 4627
ASV 21 Modulator 4625

Tail Compartment

Blue Silk Tracking Unit (Amp) 4356
Blue Silk Tracking Unit (Discriminator) 4357
Blue Silk Power Unit 4358
Radio Altimeter Mk. 5A TR 1576A
Radio Altimeter Power Unit 814

3. Comments on Installations

The above mentioned aerial and equipment installations are adequate except for the trailing aerial at the Signaller's Station. There is 12 - 18 inches of exposed aerial cable in a position where it could easily be touched by the operator. Because of the danger of 'static' shock and possibly lightning strikes, this is a flight safety hazard and it is considered essential that a bonded cover be fitted over the exposed part of the aerial cable. It has also been found that the aerial wire slips off the pulley easily.

Appendix II

Radio Compatibility

1. Introduction

Mutual interference checks were carried out on WG 556, jointly by Hawker Siddeley Aviation and A. & A.E.E. at Langar. Both ground and in-flight tests were involved. Figure 15 summarises the interferences experienced on the ground. The tests on the radio equipment were made on calculated and random frequency combinations.

2. Interference-free Equipments.

The following were clear of interference from other equipments in the aircraft.

ASV 21
Blue Silk
Radio Altimeter Mk. 5 (Mk. 5a not fitted until A. & A.E.E. trials)
STR 18B
I.F.F. 10

3. Equipments with Slight Interference

3.1 Gee 3

Transmissions from STR 18B and ASV 21 (not in-flight) caused slight interference but signal information was not degraded.

3.2 I.L.S.

Slight localiser interference was experienced on a few frequency combinations under no I.L.S. signal conditions. Common channel interference occurred between the U.H.F. and the glidepath receiver on 327 to 336 Mc/s. No interference was noted when the I.L.S. was locked on to ground signals during landing approaches.

3.3 Loran

There was some increase in receiver noise when ASV 21 was transmitting and also a very slight amount from the H.F.

3.4 Radio Compass AD 712

The audio was affected slightly by STR 18B on certain frequency combinations but there was no deterioration in A.D.F. performance.

3.5 Tacan

Audio interference arose from H.F. and U.H.F. but bearing and distance information was not degraded.

/4. ...

4. Equipments with Considerable Interference

4.1 M.F./H.F. Receiver AD 118

Heavy interference from Blue Silk was experienced at approximately 25 Kc/s. intervals throughout the bands of the receiver. Also some arose from ASV 21 and slight amounts came from certain V.H.F. frequencies and from I.F.F. 10.

4.2 Orange Harvest

Heavy audio and visual interference was caused by Blue Silk on Narrow band and sometimes on Wide band. V.H.F. transmissions caused short traces to appear in the Narrow band function. Tacan caused untunable audio and visual interference and ASV 21 caused considerable audio and some visual interference on both Narrow and Wide bands.

4.3 Twin Sonobuoy Mk. 1C

The two equipments were much the same in their susceptibility to interference. H.F. transmissions on certain frequency combinations caused quite heavy audio and visual interference. It has been shown that this is caused by direct aerial to aerial coupling of H.F. harmonics. Slight interference from U.H.F. (mainly upper aerial) occurs on certain frequency combinations.

4.4 Sarah

As expected U.H.F. transmission on and near the distress frequency caused considerable interference. Complete blotting occurs between 235 and 245 Mc/s. and traces of up to $\frac{1}{2}$ inch occur between 225 and 265.5 Mc/s. Similarly, because of its second harmonic, V.H.F. transmissions between 118 and 127 Mc/s. cause varying degrees of interference.

4.5 U.H.F. ARC 52

Heavy interference, especially on the upper U.H.F. aerial, occurs due second and third harmonics of V.H.F. transmissions. Slight interference was experienced from Blue Silk on 250 Mc/s.

4.6 V.H.F. AD 160

H.F. transmissions on certain frequency combinations cause moderate interference. There was some interference from U.H.F. which was more pronounced when the latter was keyed with the tone switch.

4.7 Intercomm

Slight breakthrough was experienced from the V.H.F., AD 118, U.H.F. and from No. 8 inverter. No. 4 inverter gave rise to a very slight whine. Numbers 5, 6 and 7 inverters caused considerable interference especially when the ASV 21 was on load but this was cured by re-routing of cables.

Appendix III

System Faults Found on Completion of Component Fit at A. & A.E.E.

1. Reversed heading sense on G.P.I. Mk. 1C with Wind Unit in A.P.I. mode of operation.

To correct this, connections to terminals 8 and 9 idented SK.2K, SK.2M respectively, on T.B.823 A.D.R.I.S. Junction Box were interchanged.

2. No E/W information on G.P.I. Mk. 1C or G.P.I. Mk. 1B with Wind Unit in G.P.I. mode and G.P.I. Junction Box selected to A.R.I. 5885. The G.P.I. Mk. 4C E/W transmitter brushes were found to be burned out. Coincident with this the G.P.I. Junction Box E/W repeater motor was jamming.

G.P.I. Mk. 4C E/W transmitter replaced and a new G.P.I. Junction Box fitted.

3. Wind Unit N.S. counter reset and wind set knobs jamming. Instrument face found to be distorted. Rectified by Bell Punch Ltd.

4. With the foregoing faults rectified, the G.P.I. Mk. 1C still appeared to function incorrectly on E/W and N/S with Wind Unit selected to G.P.I. mode and G.P.I. Junction Box switched to A.R.I. 5885 but this was resolved by A. & A.E.E. and Bell Punch Ltd., and the system functioned satisfactorily.

Summary

Some difficulty was experienced in fault diagnosis on the system due to misleading information contained in A.P.1275B Sec. 16A regarding data outputs of the G.P.I. 1B and that H.S.A. drawing V.12310 implies pin to pin looming. Distortion of the Wind Unit face and frequent loss of G.P.I. Mk. 4C output information can be attributed to the generally unsatisfactory method of securing these units in their respective mountings and in the case of the G.P.I. Mk. 4C to the electrical connections.

Items Installed on Arrival	Items Installed by A. & A.E.E.
G.P.I. Mk. 1C	Wind Unit Mk. 1
G.P.I. Mk. 1B	G.P.I. Mk. 4C
G.P.I. Mk. 4C Amplifier	Surface Movement Corrector
A.P.I.	
A.M.U.	
Wind Unit Amplifier	

Appendix IV

Shackleton Mark 2 WG 556 - Magnetic Interference Survey

1. A magnetic survey of a Phase 3 modified Shackleton Mark 2 No. WG 556 was carried out at Langar on the 1st and 2nd September 1965.

2. As the calibrated survey compasses were not available, the corrector voltages of the G.M. 7 compass systems were zeroed using a Precise Heading Test Set (P.H.T.S.) and the P.12 corrector box was removed. A 12-point swing was carried out using a Watts Datum compass as a reference. The following coefficients were observed:-

Main Compass System

Port Compass System

B -0.58 C +0.12
D -0.16 E +0.23
Standard Deviation B-E ± 0.04

Starboard Compass System

B -0.31 C -1.00
D +0.02 E +0.07
Standard Deviation B-E ±0.14

These coefficients are within Av. P. 970 limits; however since they include system coefficients, it will be necessary to repeat the swing at Boscombe Down using calibrated survey compasses at the detector unit position.

P.12 Compass Position

B +0.17 C +0.54
D +0.23 E -0.01
Standard Deviation ±0.21

These coefficients are within Av. P. 970 limits.

3. Compass interference checks were carried out on 4 headings 45 degrees apart on external supply and with the engines running. The following services were operated singly and in combinations during this check:-

Inverters, galley equipment, Tacan, A.D.F., H.F.1, H.F.2, U.H.F., V.H.F., Orange Harvest, Loran, Gee, Blue Silk, I.F.F., Sarah, Sonics, I.L.S., Radio Altimeter, A.S.V.21, external lights, autolycus, pitot heads, intercomm, boosters, de-icing, generators, internal lights, radio cooling fan and cabin heater pumps.

4. Changes of deviation outside Av. P. 970 limits were observed on the main compass systems on operation of the following services:-

(a) Up to 0.3 degrees on a northerly heading from operation of the galley, mainly due to the water heater.

(b) Up to 0.5 degrees when the taxy lamps were initially switched on.

A change of deviation of up to 0.2 degrees was observed on the starboard system when the landing lamp was switched on.

/5. ...

5. Changes of deviation outside Av.P.970 limits were observed on the P.12 compass on operation of the following services:-

galley, maximum D.C. load, engines running with generators on line.

The observed changes in degrees were:-

External Supply

Service On	N (356)	NE (047)	E (091)	SE (138)
Galley	-6	+5	+12	+11
Maximum D.C. load without galley	-5	+2	+10	+ 8

The effect of a maximum D.C. load plus galley could not be determined, as the ground power unit tended to cut out when the maximum load was selected.

Engines Running

Service	N (000)	NE (044	E (089)	SE (135)
(a) All engines running and generators on line	0	-3	-7	- 5
(b) a + selected in-flight load without galley	+4	-4	-15	-17
(c) b + galley	+3	-7	-18	-18

No significant differences were observed when various generators were taken off line with and without a load selected.

6. It is recommended that action be taken to:-

(a) Modify the galley wiring to reduce the compass interference on the main compass system. This modification should also improve the P.12 compass position.

(b) Investigate and reduce if possible the large changes of deviation observed on the P.12 compass.

/7. ...

7. It is considered that when using the Precise Heading Test Set during a calibration in service, a certain amount of confusion may be caused since the rack mountings are not labelled. In WG 556 the amplifier marked F in pencil (presumably forward) was part of No. 1 port system, and the amplifier marked B in pencil (presumably back) was part of No. 2 starboard system. The Master Indicators of the two systems are positioned with No. 2 starboard system to the forward of the aircraft. It is recommended that the rack mountings be correctly labelled in the same way that the Master Indicators and Control Units are marked.

8. The attention of A. & A.E.E. is drawn to the fact that the starboard compass system in this aircraft appears to be unreliable during a swing. Evidence of this is provided by the high standard deviation of the swing on the starboard system ($\pm$0.36 degrees) compared to that on the port system ($\pm$0.09 degrees). It might be worthwhile carrying out a swing using No. 3 inverter to provide power for both systems. This will provide an indication whether the fault lies in the compass system or in the power supplies.

from Director General, Weapons (Naval).

Appendix V

Shackleton Mark 2 WG 556 - Magnetic Survey No. 1

1. A visit was made to Boscombe Down on the 22nd September 1965 to complete the magnetic survey of a Shackleton Mk. 2, No. WG 556.

2. The port and starboard compass detector units were replaced by calibrated survey compasses, and a 16-point swing carried out using a Watts Datum Compass as a reference. The following coefficients in degrees were observed as being caused by the aircraft structure:

Port Detector Unit Position		Starboard Detector Unit Position	
B - 0.02	C + 0.07	B + 0.21	C + 0.22
D - 0.70	E + 0.52	D - 0.00	E - 0.26
Standard Deviation B-E ±0.04		Standard Deviation B-E ±0.03	

Coefficients D and E at the port detector unit position are well outside Av. P. 970 limits, and coefficient E at the starboard detector unit position is marginally outside.

3. On examination of the detector unit positions it was found that:-

(a) At both detector unit positions, the bolt holding the clip on the detector unit cable about 8" aft of the detector unit was made of magnetic material.

(b) At the port detector unit position, the anchor nuts holding the detector unit bracket and the airframe were very magnetic.

4. It is recommended that the firm ensure that the drawings call for non-magnetic items in these positions, and also that the firm's inspection department ensure that only non-magnetic items are fitted.

5. It is essential that an aircraft with these items made of non-magnetic material is available for assessment as soon as possible. The aircraft No. WG 556 currently on assessment at A. & A.E.E. should be modified as soon as possible so that the current trials programme is not prejudiced. Arrangements for further surveys should be arranged through M.O.A. (Nav. 1(b)) so that the work can be fitted into the existing programme.

(J. HOWARD)
for Director General
Weapons (Naval)

Appendix VI

Shackleton Mark 2 WG 556 - Magnetic Survey No. 2

1. A visit was made to Boscombe Down on the 20th October 1965 to carry out a further swing of a Shackleton Mk. 2 No. WG 556. The magnetic material found on the previous survey (reported in letter CD/15/3029/65 dated 1st October, 1965) had been removed by A. & A.E.E. staff and non-magnetic items fitted.

2. Both detector units were replaced by calibrated survey compasses and a 16-point swing was carried out using a Watts Datum Compass as a reference. The following coefficients in degrees due to the aircraft structure were observed:-

Port Detector Unit Position		Starboard Detector Unit Position	
B + 0.19	C + 0.02	B + 1.63	C + 0.42
D - 0.24	E + 0.46	D - 0.09	E - 0.30
Standard Deviation B-E ±0.04		Standard Deviation B-E ±0.04	

Coefficient E at both detector unit positions is outside Av. P. 970 limits, and coefficient D at the starboard detector unit position is marginally within Av. P. 970 limits.

3. It is requested that this aircraft is made available for a further swing at a convenient time in the current trials programme. A search for magnetic material will be carried out at the same time, to see if the coefficients can be brought within Av. P. 970 limits.

4. It is recommended that the firm ensure by careful inspection that Av. P. 970 requirements are met on production aircraft.

(R. W. WATSON)
for Director General Weapons(Naval)

Appendix VII

Shackleton Mk. 2 Phase 3 WG 556

Summary of Compass Swings

1.

Date	System No. 1 A	B	C	D	E	Σ	System No. 2 A	B	C	D	E	Σ	Remarks
7 October	0	−0.31	+0.01	−0.85	+0.32	0.17	+0.33	−0.85	−0.07	−0.66	+0.14	0.24	Magnetic Material Near D.U.S.
21 October	−0.02	−0.01	+0.29	−0.31	+0.23	0.14	+0.02	+0.06	0	−0.39	+0.03	0.18	Both Systems No. 3 Inverter
22 November	+0.04	−0.27	+0.48	−0.30	+0.09	0.16	+0.02	−0.32	+0.24	−0.51	−0.02	0.14	No. 3 Inverter - Windy day
22 November	+0.18	−0.10	+0.56	−0.33	+0.07	0.19	+0.20	−0.04	+0.15	−0.41	+0.19	0.16	No. 3 Inverter - Windy day
22 November	+0.24	−0.08	+0.64	−0.25	+0.13	0.15	+0.16	−0.10	+0.07	−0.45	+0.12	0.17	No. 1 System No. 1 Inverter No. 2 System No. 2 Inverter
27 November	+0.13	−0.21	+0.15	−0.55	+0.05	0.11	0	+0.05	−0.08	−0.42	+0.07	0.11	No. 1 System No. 1 Inverter No. 2 System No. 2 Inverter Calm Day
27 November	+0.32	−0.29	+0.19	−0.25	+0.27	0.10	+0.19	+0.08	−0.13	−0.49	+0.12	0.11	No. 1 System No. 1 Inverter No. 2 System No. 2 Inverter Calm Day
27 November	+0.34	−0.25	+0.05	−0.17	+0.29	0.06	+0.25	−0.04	+0.25	−0.35	+0.20	0.08	Detectors tapped continually
Mean of last 7 swings	+0.18	−0.17	+0.34	−0.31	+0.16	0.13	+0.14	−0.04	+0.07	−0.43	+0.10	0.14	
13 October	−0.10	+0.05	−0.47	−0.23	+0.08	0.22	−0.03	+0.17	−0.41	−0.31	+0.03	0.17	Air swing - correction of +0.70 to No. 1 and −0.70 No. 2
25 November	+0.01	−0.13	+0.20	−0.11	+0.26	0.25	0	+0.05	+0.20	−0.24	+0.23	0.27	Air swing - correction of +0.70 to No. 1 and −0.70 No. 2
Mean of air swings	−0.05	−0.04	−0.13	−0.17	+0.17	0.23	−0.01	+0.11	−0.10	−0.27	+0.13	0.22	

2. From the results tabulated above the following information was extracted:

(a) The 1σ variation of the B and C coefficients determined in the seven ground swings about their means is

$$\Sigma \frac{\Delta^2}{N-4} = 0.16^\circ$$

(b) The 1σ variation of the corresponding D and E coefficients about their means is

$$\Sigma \frac{\Delta^2}{N-4} = 0.09^\circ$$

3. In addition to the above, the squares of the difference between the deviations measured on each heading and their individual means were summated to yield a 1σ error of $\Sigma \frac{\Delta^2}{N-12} = 0.26^\circ$ in any individual reading.
This corresponds to a probable erroroof 0.17° in the compass reading at any given time.

/4. ...

4. Because the V.S.C. was re-set prior to each days work, comparison between A coefficients could only be made between values found on the same day. For these small samples, the 1 value of the variation between A coefficients was found to be 0.11°. Because of the smallness of the sample (4 x 3) no particular importance is attached to this figure except to note that it is roughly comparable in magnitude to the variation in D and E coefficients and noticeably less than the variation in B and C values.

5. No significant difference was detected between the results obtained with both ystems running from the same inverter and those found when separate inverters were used.

6. Smaller probable errors were obtained in the Fourier analysis of results obtained on a calm day than those found on a day of moderate wind, but there was no significant lessening of the spread about the means. The smallest probable errors found during the swings were achieved by continual tapping of the detector units during readings. The results of this swing were, however, no closer to the mean than the results of several other swings and the probable errors determined during Fourier analysis were completely misleading when compared with the true differences from the means.

7. The air swings were accomplished by inserting a periscopic sextant mount on a blanking plate affixed to the base of the astro-dome. As a result, the readings obtained were affected to a certain extent by refraction caused by the astro-dome. To provide room for the sextant operator's head it was necessary to place the mount slightly off-centre to starboard. This offset had the effect of increasing dome refraction effects on fore and aft sextant observations. Because the 13th of October swing was performed at approximately local noon this caused the C coefficients to vary by about 0.5° from those expected from ground results. The 25th of November results were obtained later in the day and with the sun at a lower altitude. Under these conditions, dome refraction effects were spread more equally between the B and C coefficients and are not so noticeable in the results. Apart from the C coefficient discrepancy already mentioned, and for a correction of +0.70° to the No. 1 and -0.70° to the No. 2 system for A errors occasioned by wing flexure in flight, coefficients measured in the air agree within the bounds of the variations outlined in para. 2 to those found on the ground. This result indicates that the behaviour of the GM 7 system in the air is very similar to its behaviour on the ground, and that swinging the compass system on the ground and applying corrections of +0.70° to the No. 1 system and -0.70° to the No. 2 system is an effective method of adjusting the compasses for accurate performance in the air.

Appendix VIII

Remote Corrector Unit Voltages Measured During Compass Swings

1.

Swing No.	No. 1 System		No. 2 System	
21 October	B + 0.22	C + 0.07	B + 1.73	C - 0.15
22 November - 1	B + 0.24	C + 0.06	B + 1.73	C - 0.13
22 November - 2	B + 0.23	C + 0.05	B + 1.72	C - 0.17
22 November - 3	B + 0.23	C + 0.05	B + 1.72	C - 0.17
27 November - 1	B + 0.22	C + 0.03	B + 1.71	C - 0.17
27 November - 2	B + 0.22	C + 0.07	B + 1.71	C - 0.15
27 November - 3	B + 0.21	C + 0.07	B + 1.72	C - 0.13

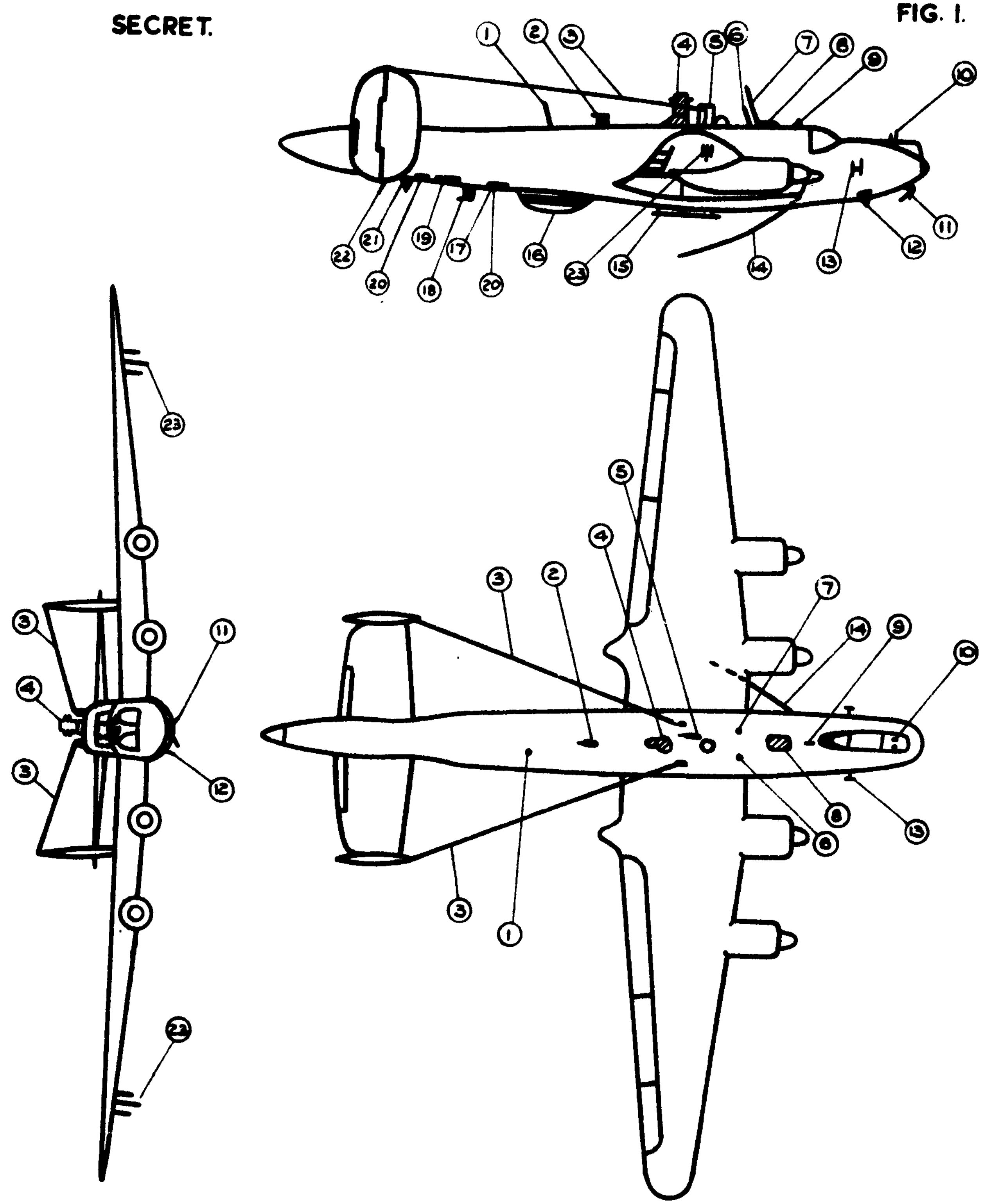
2. These readings were made using the voltmeter of the Precise Heading Test Set. As a result, the second decimal place could only be determined by estimation. Every effort was made to ensure that the conditions under which the meter was read and the estimation performed were as similar as possible, but, because of the coarseness of the P.H.T.S. scale, some parallax error may still have occurred.

B 3697 | 20TH PART OF REPORT No A.&A.E.E./866/2 | SHACKLETON MK3. PHASE 3 WR 974 | TRKG. | CH. F/LT. CASTLE | APP. R.E.W. for S of N.R. 16 4·2

BK.83697 | 1ST PART/866/5 | SHACKLETON MK2. PHASE 3 WG 556 | CH. MR. WITHERS

SECRET.

FIG. 1.



1 SONO BUOY
2 UHF UPPER
3 FIXED WIRE AERIALS (HF1 & HF2 OR LORAN)
4 ORANGE HARVEST
5 V.H.F
6 SONO BUOY
7 GEE III
8 RADIO COMPASS LOOP
9 IFF 10 UPPER
10 VIOLET PICTURE
11 ILS LOCALISER & GLIDEPATH
12 TACAN
13 SARAH HOMER
14 TRAILING AERIAL (LORAN OR HF 2)
15 RADIO COMPASS SENSE
16 ASV 21
17 ILS MARKER (ON CENTRE LINE)
18 UHF LOWER
19 BLUE SILK
20 RADIO ALTIMETER SA (ON PORT SIDE)
21 IFF 10 LOWER
22 SARAH TRANSMITTER
23 SONOBUOY HOMER

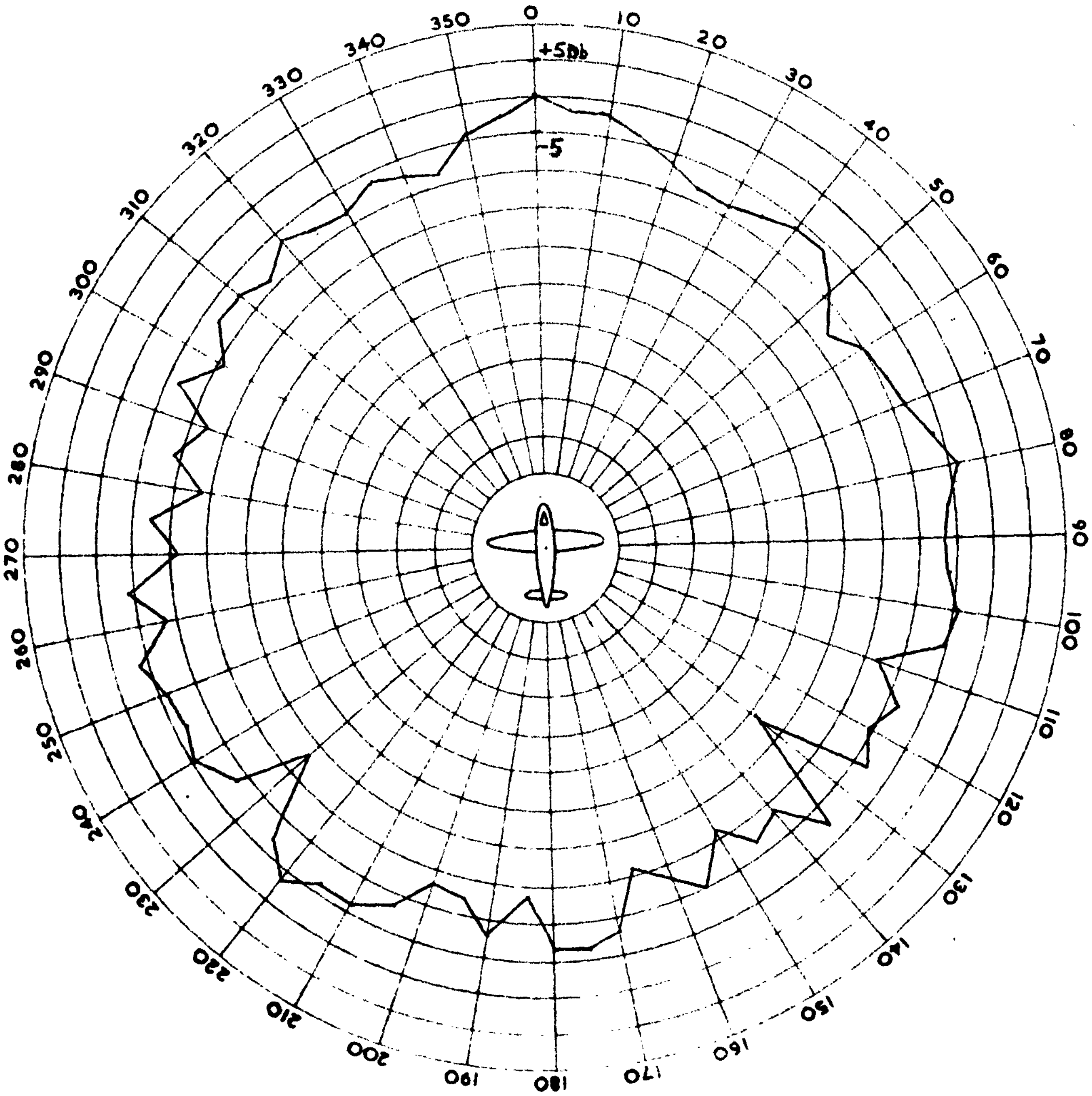
SECRET.

DIAGRAMMATIC SKETCH OF AERIAL POSITIONS.

SECRET

FIG. 2.

SK.B.4182 | REPORT No. 151. PART 1866/5 | A/C SHACKLETON MR.2
PHASE 3 WG 556



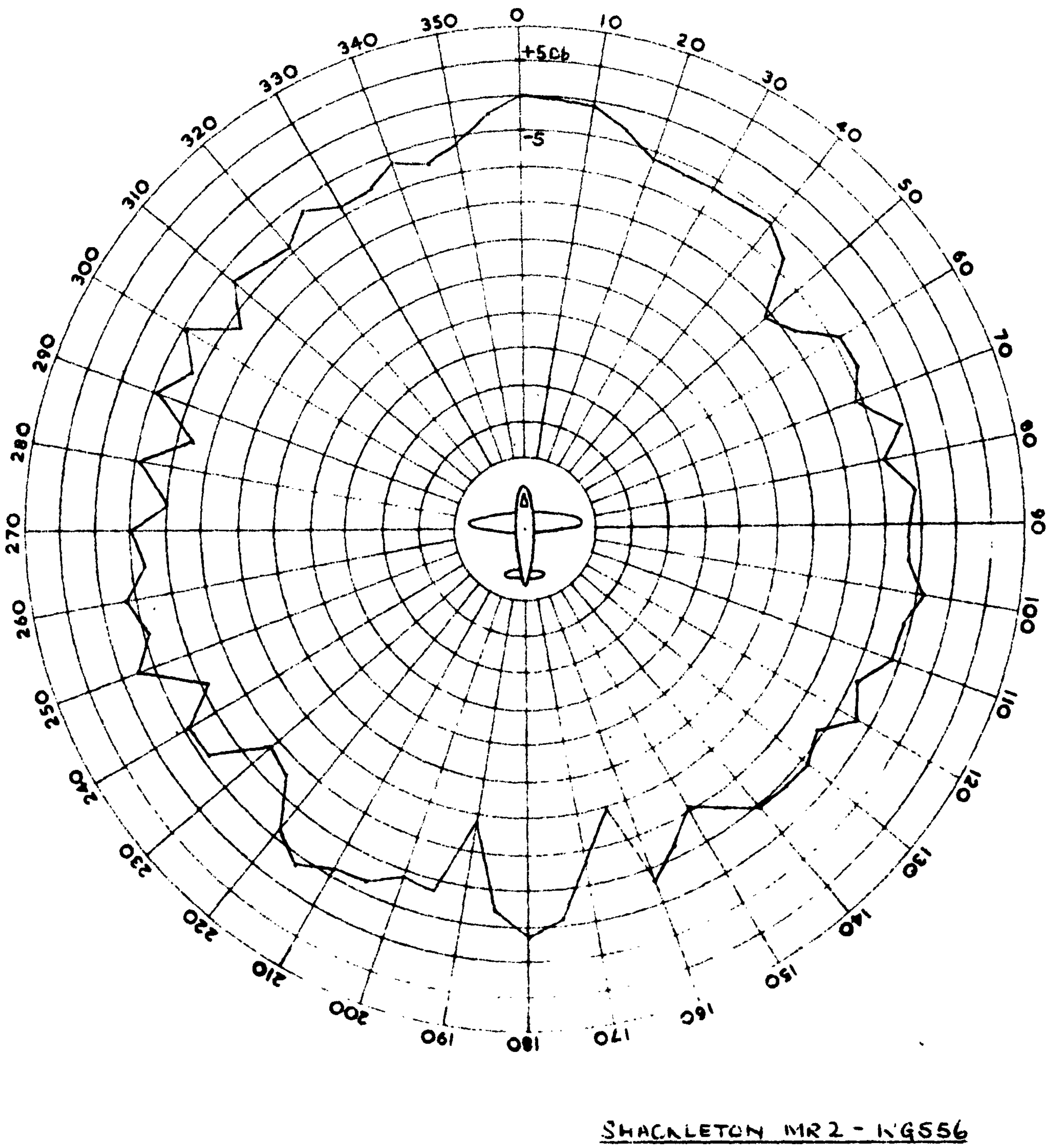
118 Mc/s

SHACKLETON MR 2 - WG 556
V.H.F. AERIAL
AZIMUTH RADIATION PATTERN
GROUND MEASUREMENT

SECRET

FIG 3

SECRET



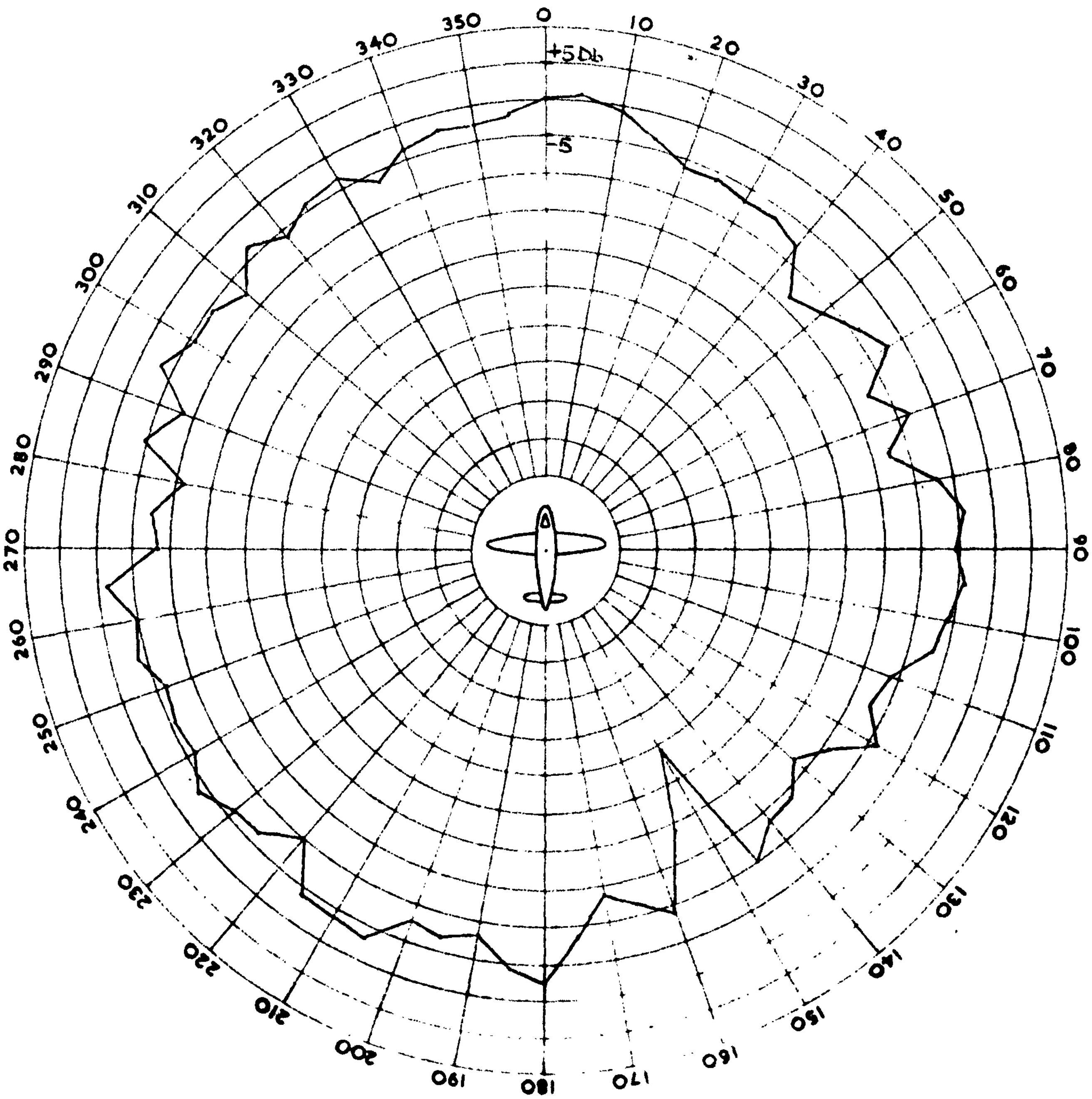
PHASE 3 WG 556

127 Mc/s

SHACKLETON MR2 - WG556
V.H.F. AERIAL
AZIMUTH RADIATION PATTERN
GROUND MEASUREMENT

SECRET

FIG 4



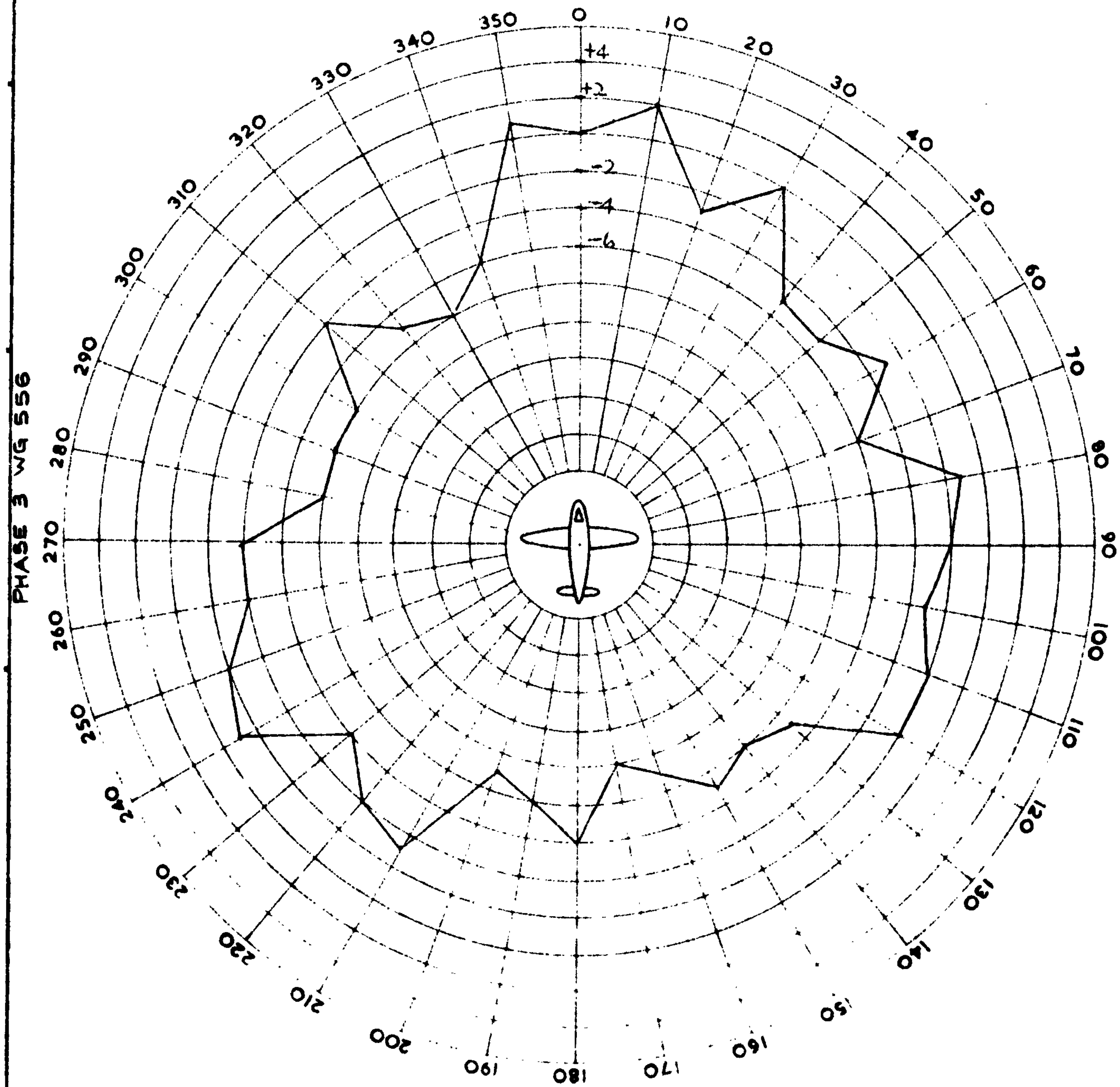
PHASE 3 WG 556

SHACKLETON MR 2 - WG 556
V.H.F. AERIAL
AZIMUTH RADIATION PATTERN
GROUND MEASUREMENT

135 Mc/s

FIG 5

SECRET



118 Mc/s

0Db = 60 μV/M

SHACKLETON MR2 - WG556

V.H.F RADIATION PATTERN

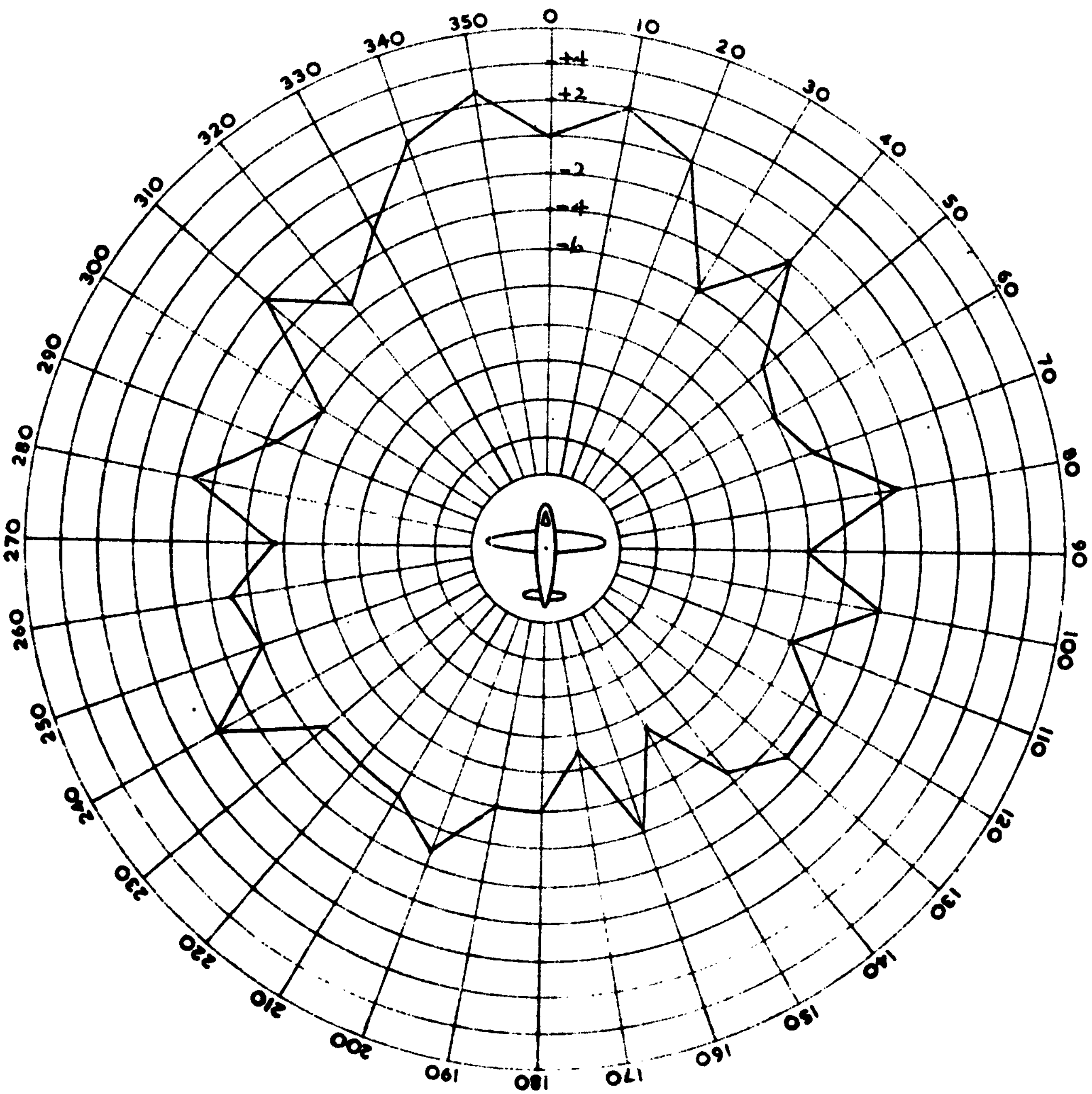
HEIGHT - 5000 FEET

RANGE :- 70 N MLS

SECRET

SECRET

FIG 6



135 Mc/s

0 Db = 60 μ V/M

SHACKLETON MR2 - WG556

V.H.F. RADIATION PATTERN

HEIGHT :- 8000 FEET

RANGE :- 70 N. MLS.

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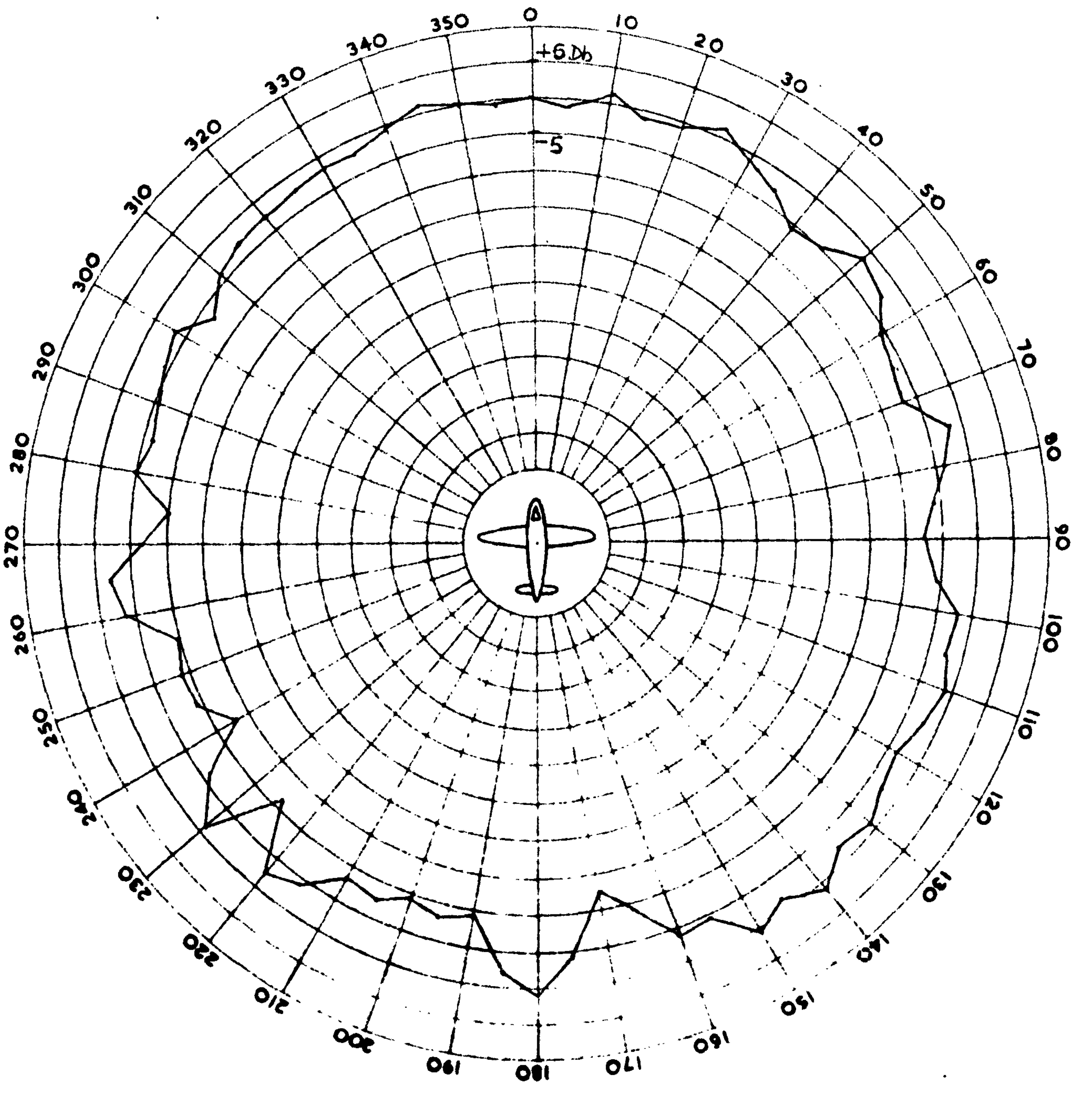
SK. 12418 | K.H.P.URI No. 1ST. PART/ABG6/5 | A/C SHACKLETON MK.2 PHASE 3 WG 556 | CH. | APP. | for S of

SECRET

FIG 7



162 Mc/s

SHACKLETON MR. 2 - WG 556
SONO BUOY 1C AERIAL (FWD)
AZIMUTH RADIATION PATTERN
GROUND MEASUREMENT

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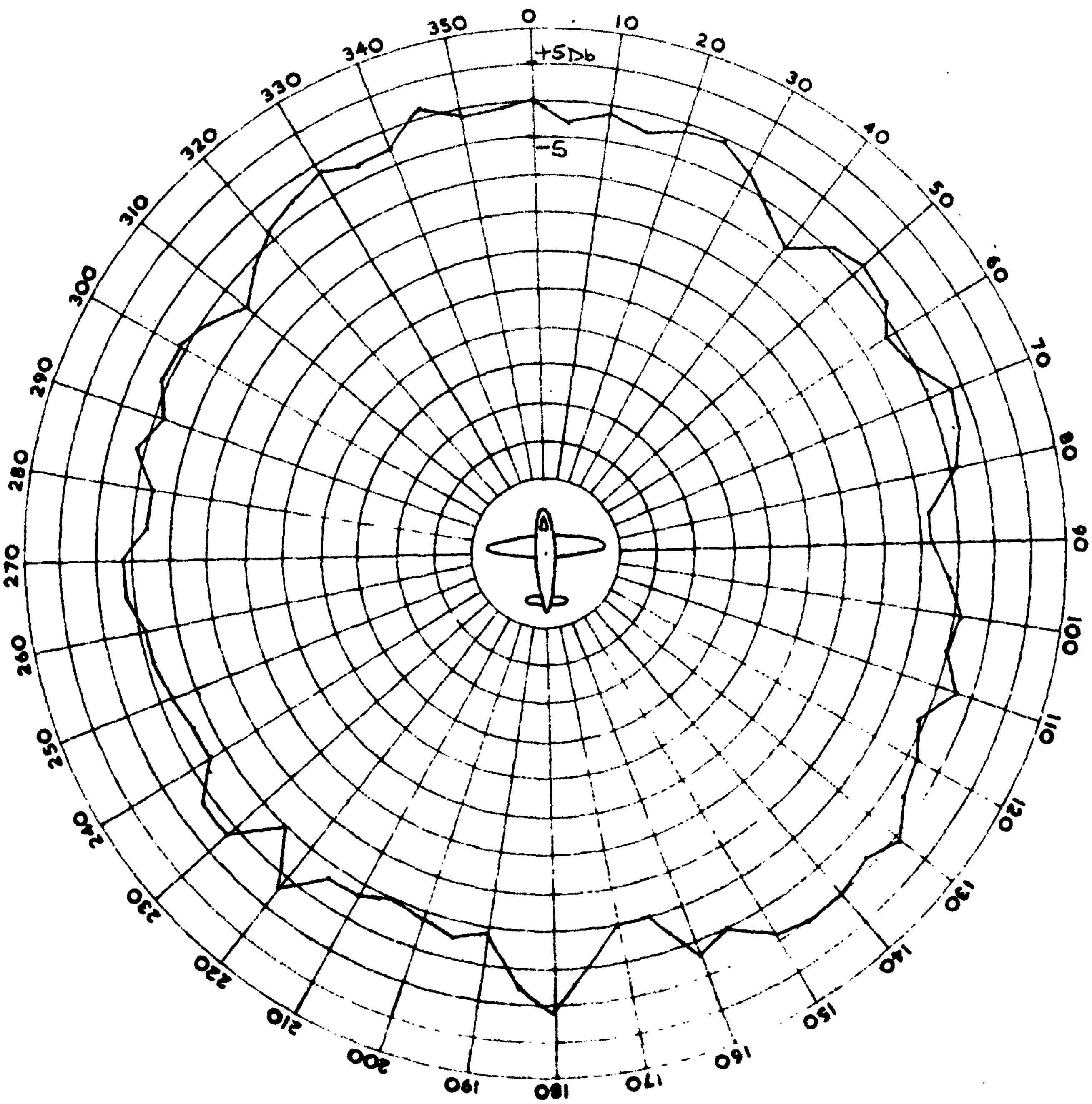
SK. B4187 | REPORT No. 1st PART/866/5 | A/C SHACKLETON MK. 2. PHASE 3 WG 556 | CH. | APP. | fot S of

FIG 8



168 Mc/s

SHACKLETON MR2 WG556
SONO BUOY 1c AERIAL (FWD)
AZIMUTH RADIATION PATTERN
GROUND MEASUREMENT

SK. B4188 | REPORT No. 1st PART/866/5 | A/C SHACKLETON MK2 PHASE 3 WG 556 | CH. | APP.

FIG 9

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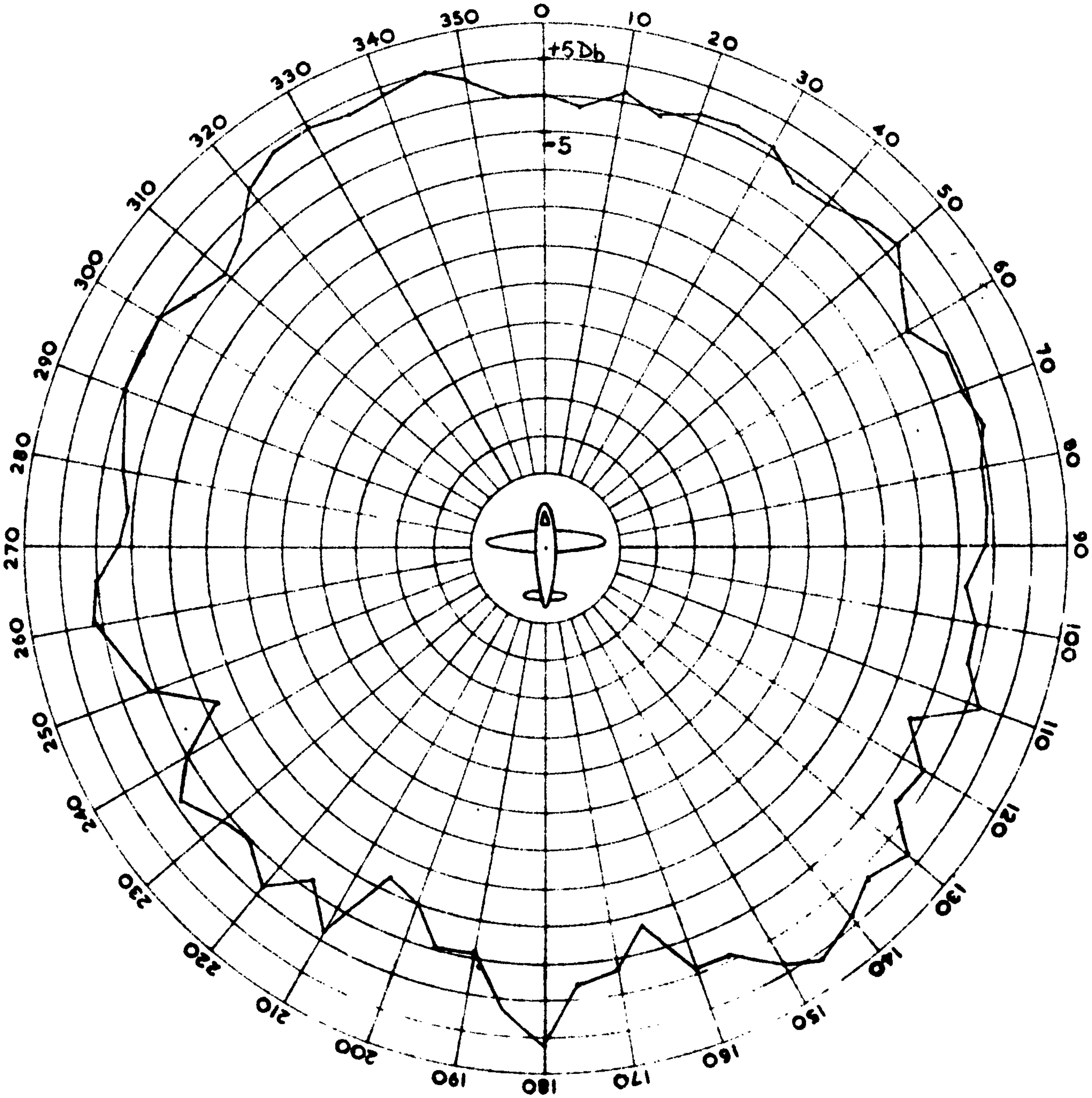

172 Mc/s

SHACKLETON MR 2 - WR 556

SONO - BUOY 1C AERIAL (FWD)

AZIMUTH RADIATION PATTERN

GROUND MEASUREMENT

SK.B 4189 | REPORT No. 1ST. PART /866/5 | A/C SHACKLETON MK2 PHASE 3 WG 556 | CH. | APP. | for S of | RZ

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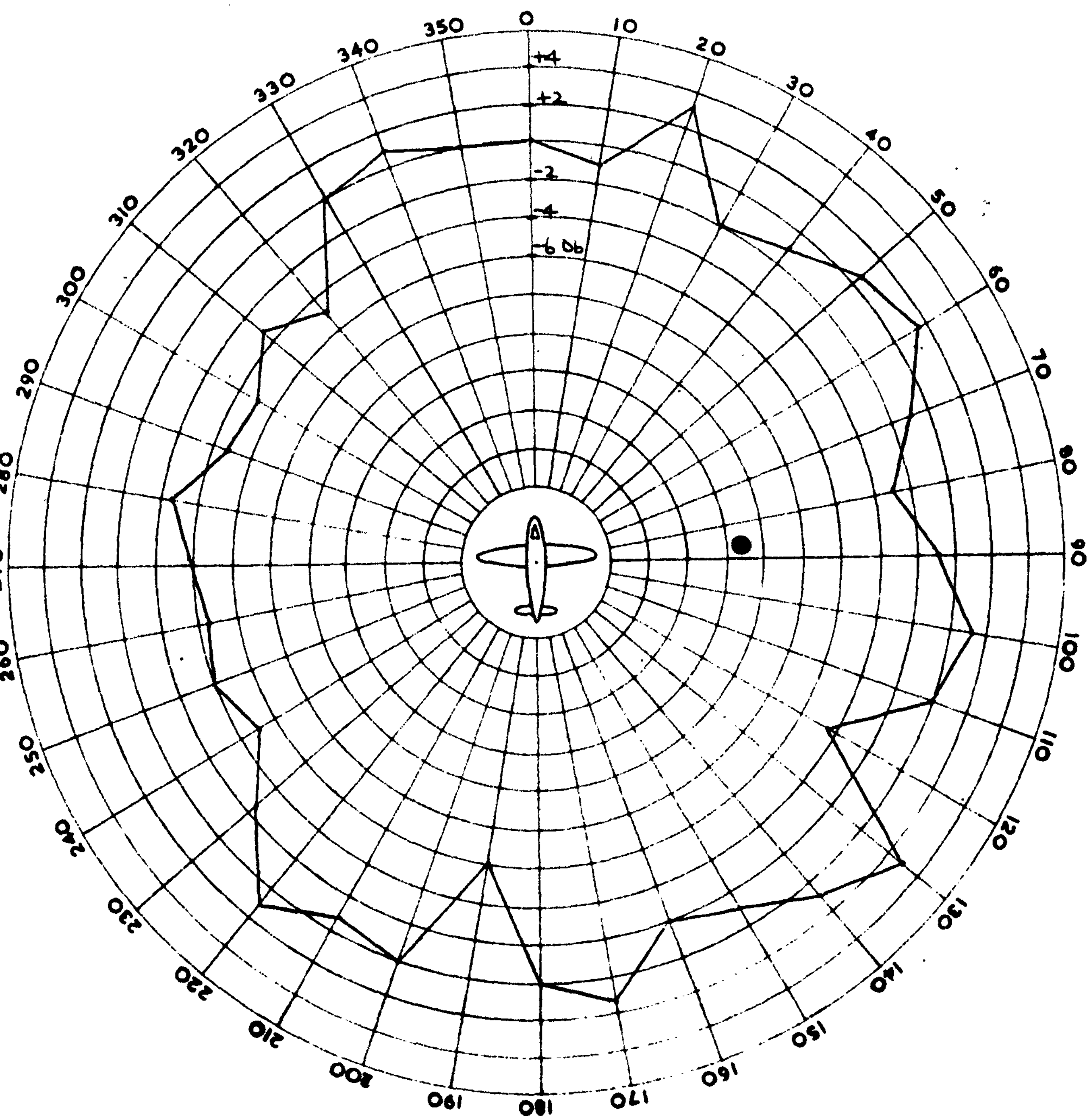
SECRET



168 Mc/s

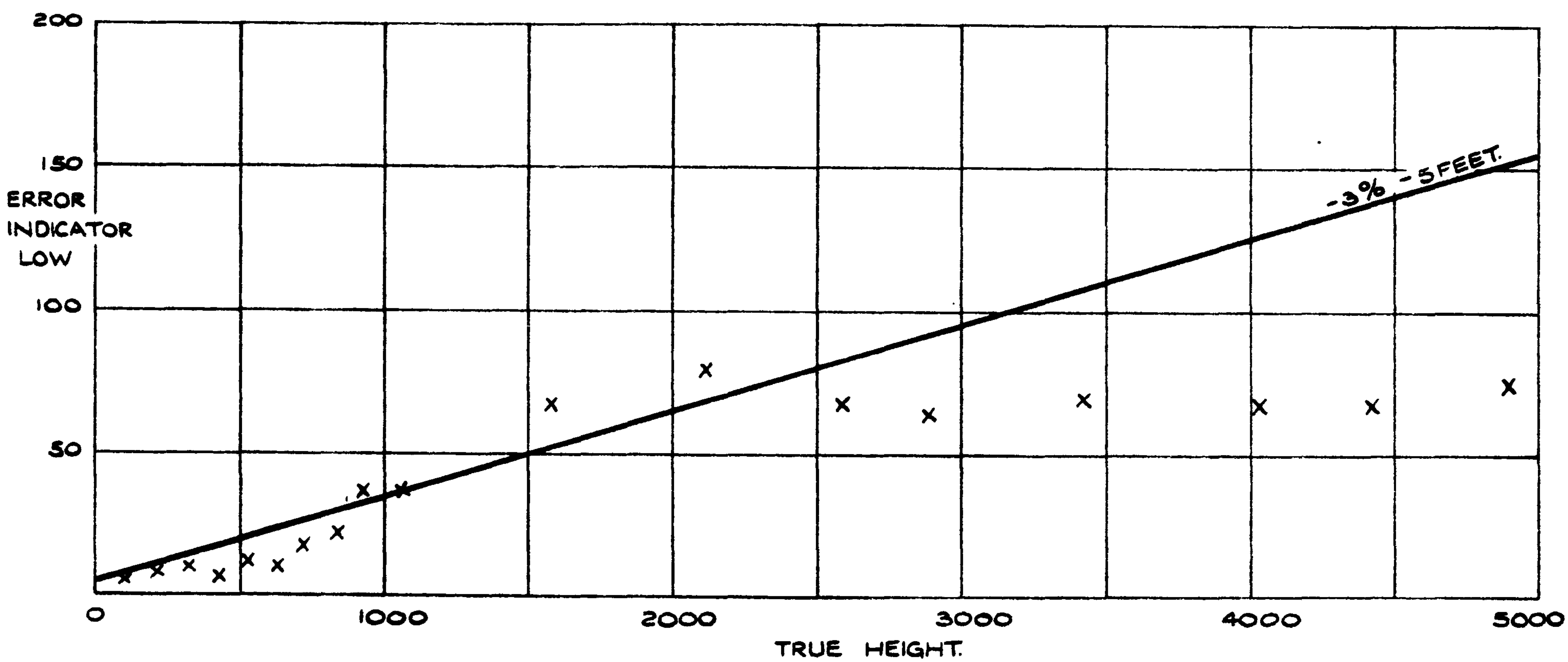
SHACKLETON MK2 WG556
SONO BUOY 1C OMNI (FWD)
HEIGHT:- 8000 FEET
RANGE:- 70 N.MLS

SECRET

SECRET.

SK.84033	REPORT No. 1ST PART/066/5	A/C SHACKLETON MK.2	CH. MR. WITHERS.	APP. Rlw for S of N.R.	4·2·66

PHASE 3 WG 556



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RADIO ALTIMETER CALIBRATION HEIGHT INDICATION ACCURACY.

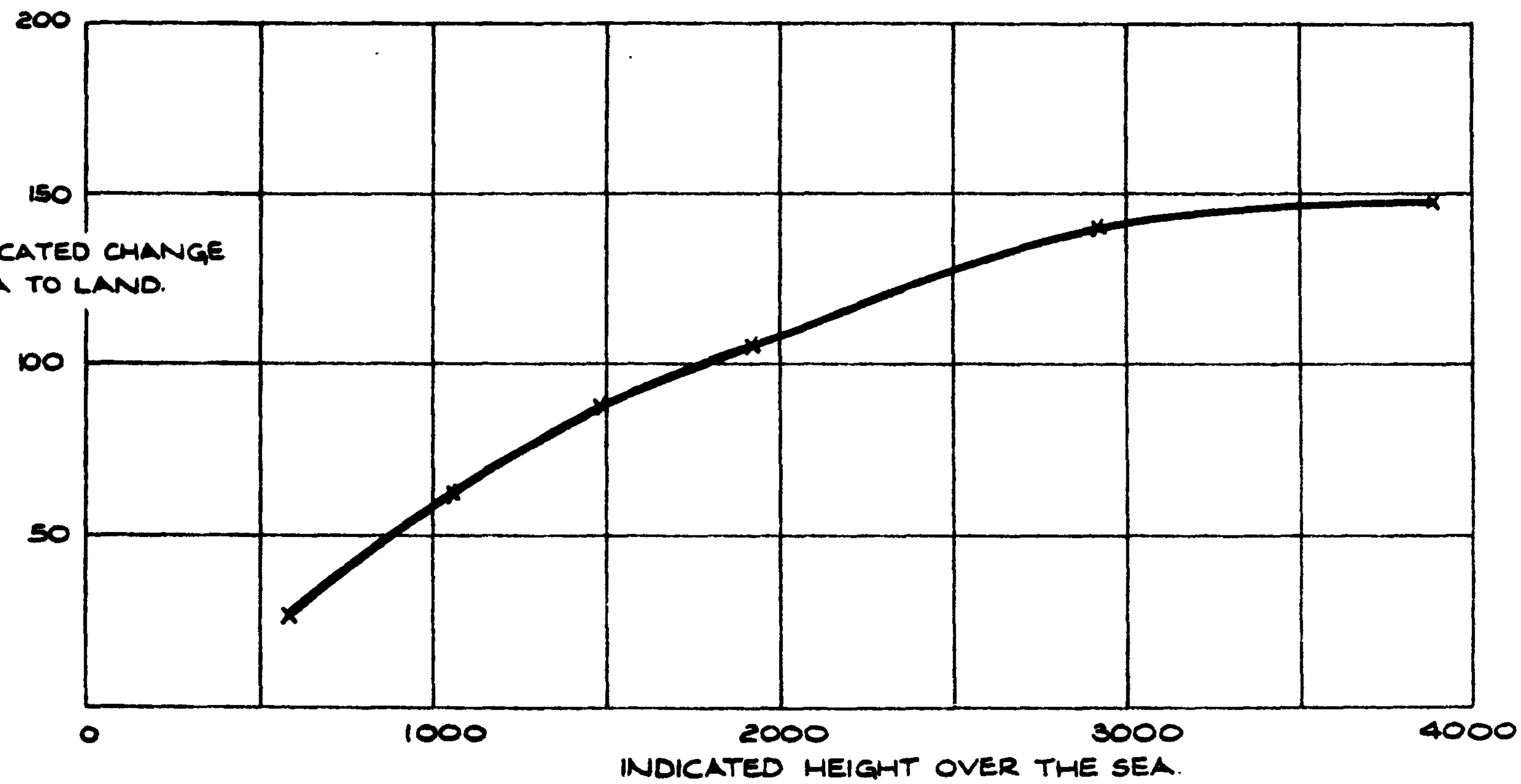
FIG. 11.

SECRET.

FIG. 12.

SK.B4034 | REPORT No. 1st PART / 866/5 | A/C SHACKLETON MK2 | CH. MR. WITHERS. | APP. R.E.W. for S of M.E. | 4.2.66 | R

PHASE 3 WG 556



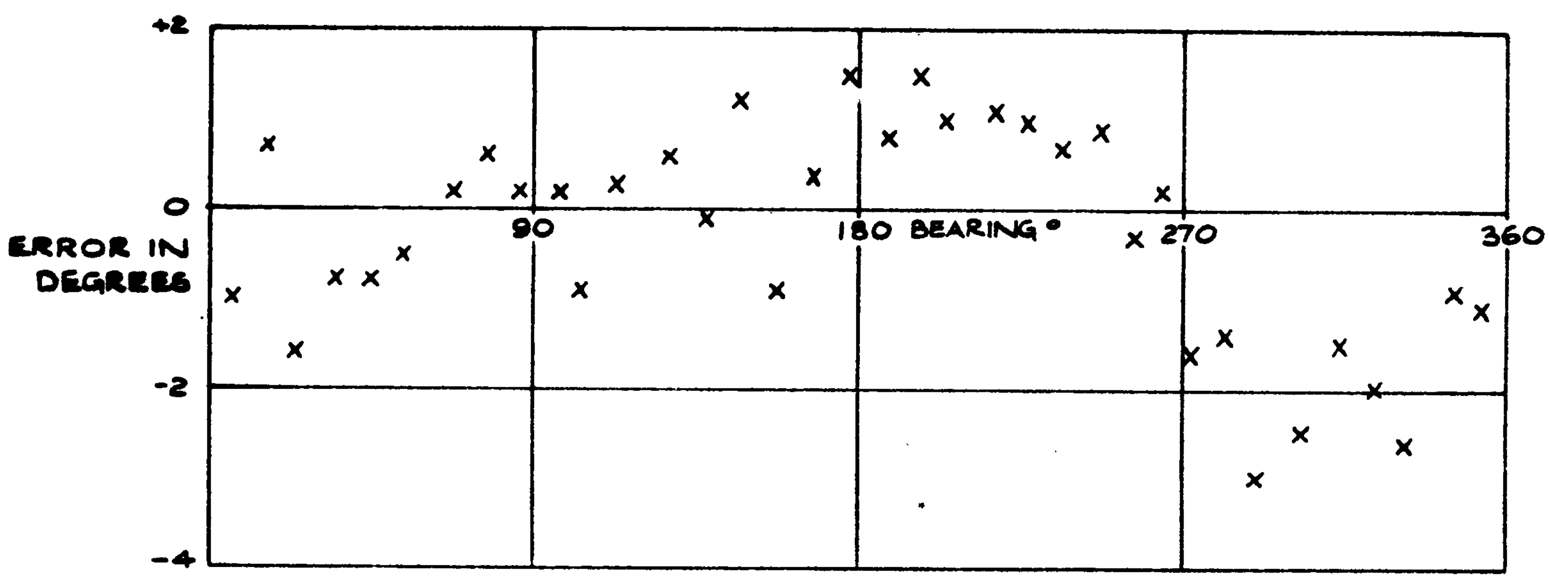
RADIO ALTIMETER CALIBRATION SEA TO LAND CHANGE.

SECRET.

SK.B 4035	REPORT No. 1ST PART/866/5	A/C SHACKLETON MK2	CH. MR. WITHERS.	APP.	for S of	4·2·66

R5

PHASE 3 WG 556

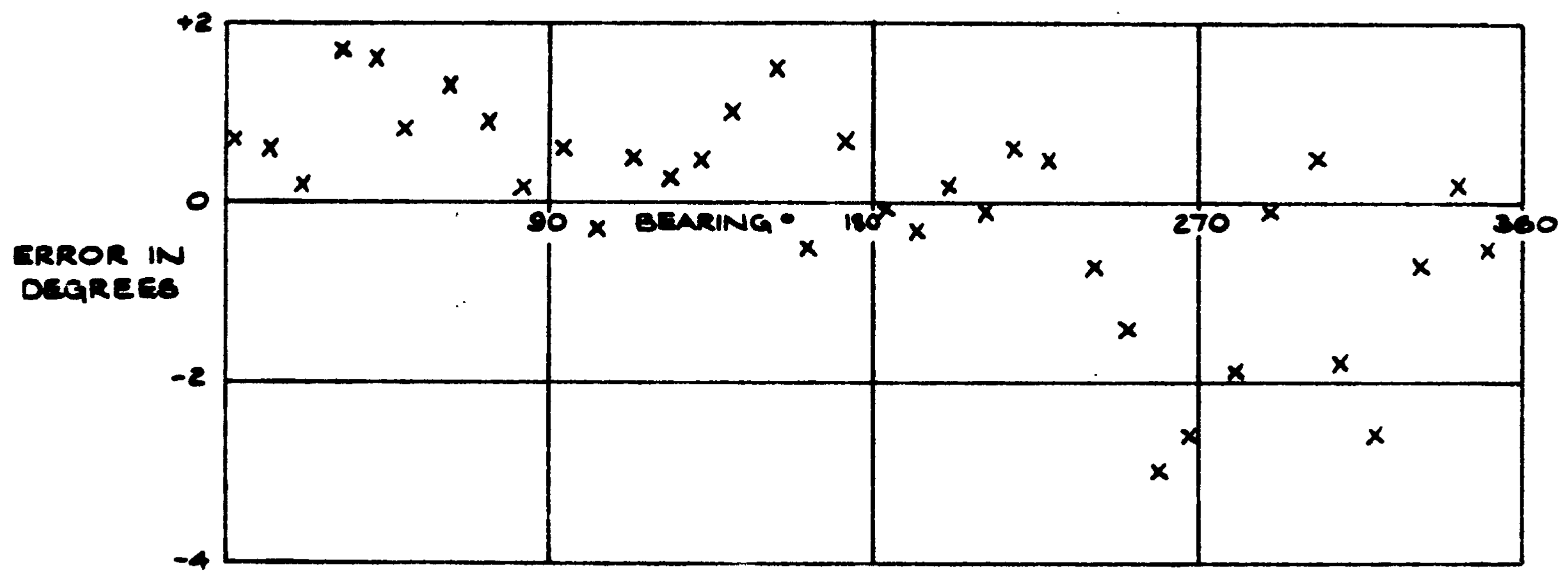


RADIO COMPASS GROUND SWING ON 908 Kc/s.

FIG. 13.

SK.84036	REPORT No. 1st PART/866/5	A/C SHACKLETON MK.2	CH. MR. WITHERS.	APP. R.E.W. for S of N.R.	4·2·66	R5

PHASE 3 WG 556



RADIO COMPASS GROUND SWING ON 200 Kc/s.

	U.H.F. ARC 52	V.H.F. AD 160	H.F. STR 13	TACAN	I.F.F. 10	A.S.V. 21	Blue Silk	Radio Altimeter 5A	Orange Harvest	MF/HF Receiver AD 118	Twin Sonobuoy Mk. 1C	Radio Compass AD 712	I.L.S.	Gee 3	Loran 2	Sarah	Intercomm
U.H.F. ARC 52		Slight	Nil	Slight	Nil	Nil	Nil	Nil	Nil	Nil	Yes	Nil	Yes	Nil	Nil	Yes	Nil
V.H.F. AD 160	Yes		Yes	Nil	Nil	Nil	Nil	Nil	Yes	Yes	Slight	Nil	Yes	Nil	Nil	Yes	Slight
H.F. STR 13	Yes	Yes		Yes	Nil	Nil	Nil	Nil	Yes		Yes	Yes	Nil	Yes	Nil	Nil	Yes
TACAN	Nil	Nil	Nil		Nil	Nil	Nil	Nil	Yes	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
I.F.F.10	Nil	Nil	Nil	Nil		Nil	Nil	Nil	Nil	Slight	Nil	Nil	Nil	Nil	Nil	Nil	Nil
ASV 21	Nil	Yes	Nil	Nil	Nil		Nil	Nil	Yes	Yes	Nil	Nil	Nil	Yes	Yes	Nil	Nil*
Blue Silk	Slight	Nil	Nil	Nil	Nil	Nil		Nil	Yes	Yes	Nil	Nil	Nil	Nil	Nil	Nil	Yes
Radio Altimeter 5A	Nil	Nil	Nil	Nil	Nil	Nil	Nil		Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil

*But see Appendix II para. 4.7

FIG. 15

Summary of Ground Compatibility Trials
Showing Presence of Interference

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These abstract cards are inserted in Reports for the convenience of Librarians and others who need to maintain an Information Index.

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1st Part of Report No. A&AEE/866/5 9. 5.66
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Sqn.Ldr. D.A.Stonehouse,R.C.A.F. & Flt.Lt. R.E.Griffiths,B.Sc.(Eng.)

SHACKLETON MK. 2 PHASE 3
NAVIGATION AND RADIO C.A. RELEASE TRIALS

C.A. release trials were carried out in Shackleton Mk. 2 Phase 3 WG 556. Trials flying totalled 32 hours 55 minutes in 12 sorties.

Temperate release is recommended for the use of the navigation and radio equipment subject to the reservations contained in this report. Installations remaining unchanged from the Phase 2 Mk. 2 Shackleton are cleared by analogy to that aircraft.

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